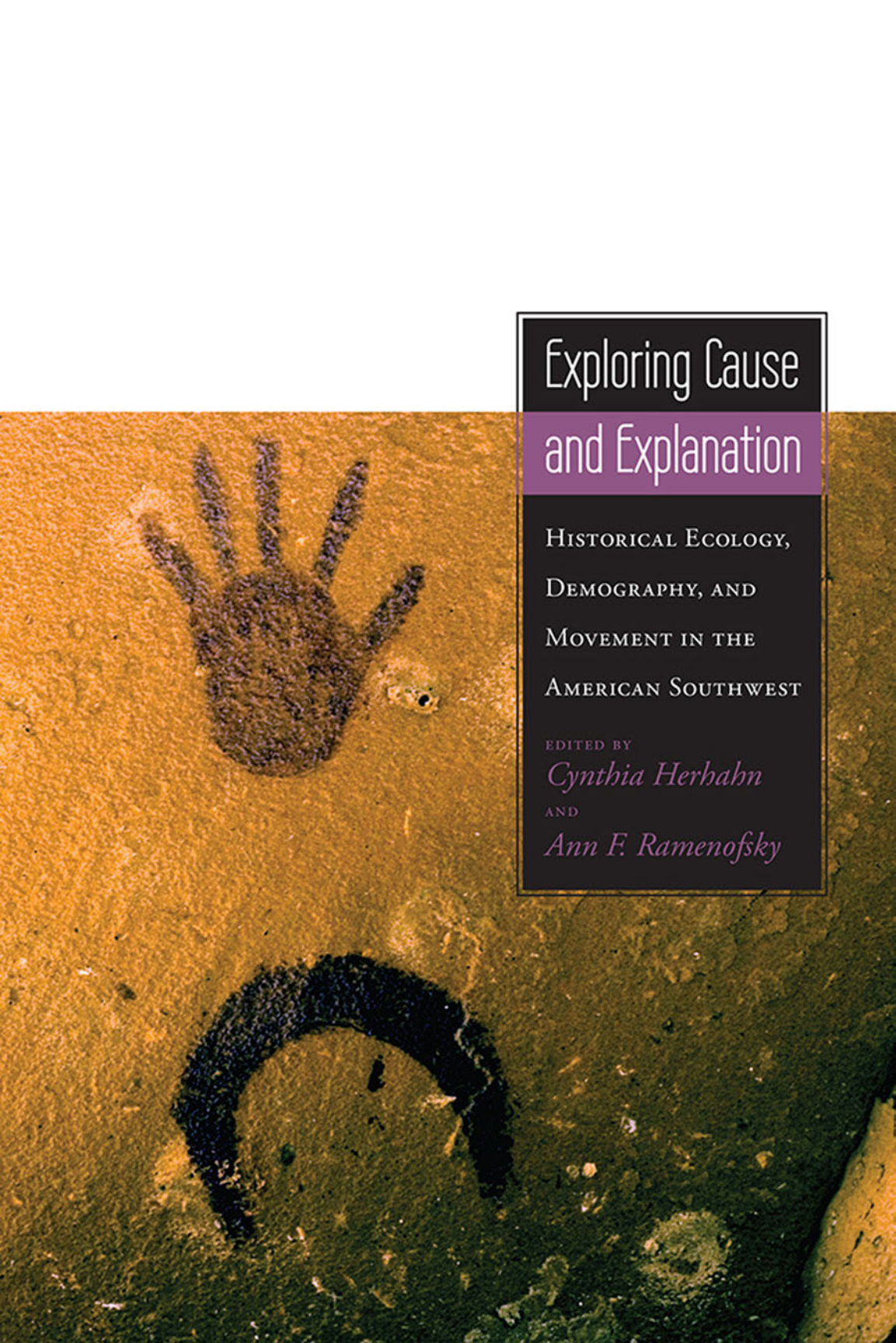


The background of the book cover is a photograph of ancient rock art. In the upper left, there is a large, dark, textured handprint. Below it, towards the bottom center, is a dark, circular petroglyphic figure with a thick, curved line forming its body. The rock surface is uneven, with shades of orange, brown, and green.

Exploring Cause and Explanation

HISTORICAL ECOLOGY,
DEMOGRAPHY, AND
MOVEMENT IN THE
AMERICAN SOUTHWEST

EDITED BY

Cynthia Herhahn

AND

Ann F. Ramenofsky

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Exploring Cause and Explanation

Proceedings of the Southwest Symposium

*The Archaeology of Regional Interaction: Religion, Warfare, and Exchange
across the American Southwest and Beyond*

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AMERICAN SOUTHWEST

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Cynthia L. Herhahn

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Ann F. Ramenofsky

13th Biennial Southwest Symposium
University of New Mexico, Albuquerque

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IN MEMORIUM

Lewis R. Binford, Linda Cordell, and Robert C. Dunnell
... they changed the ways we think about the past.

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Exploring Cause and Explanation

The Challenges of Cause and Explanation in Historical Ecology, Demography, and Movement

ANN F. RAMENOFSKY AND CYNTHIA L. HERHAHN

One goal of the 13th Biennial Southwest Symposium was to explore the current state of regional archaeological knowledge across three significant themes—historical ecology, demography, and movement—recently highlighted by Keith Kintigh and colleagues as grand challenges in the discipline (Kintigh et al. 2014). Movement and ecology have been emphasized in many Southwest symposia (Cameron 1995; Fish and Reid 1996; Hegmon 2000; M. C. Nelson and Strawhacker 2011), but demography has received less attention. In the 1992 symposium (Fish and Reid 1996), demography was linked to organizational complexity, and demographic papers have appeared occasionally in other volumes (Creamer et al. 2002; Doelle 2011; Ramenofsky et al. 2011). Here, however, demography is treated as an independent domain in archaeological investigations. We viewed this focus as essential. Although trivial to say, without people there is no archaeological record.

Another goal of this volume is to consider the broader epistemological issues of cause and explanation in archaeology. The incorporation of these concepts is significant on several fronts. They provide the contextual and theoretical “glue” that binds the three themes together into a coherent whole. Consideration of cause and explanation honors the contributions of Southwest archaeologists to the discipline as a whole (Cordell and Plog 1979; Fritz and Plog 1970; Plog 1974, 1981), adding intellectual depth to all the case studies or discussions and reminding us about the “confines of normative thought.” Of equal importance, using these concepts

facilitates assessing the current and past state of knowledge within each domain. The assessment, in turn, ties back into the structure of the Southwest Symposium. The biennial meeting and subsequent publications of papers create a permanent record of development and change in archaeological knowledge that can be continually revisited. This structure allows us to evaluate older ideas and theories in light of new fieldwork and introduce new methods and techniques to evaluate what we thought we knew only a few years earlier.

Given the importance of cause and explanation to the volume as a whole, we begin by discussing these concepts at the scale of the discipline. To be consistent with this scale, we extend this discussion by examining cause and explanation within each theme at regional scales both outside and within the Southwest. This examination contextualizes how section leaders structured their topics. We end this chapter by introducing the organizational structure of the sections addressing each theme.

CAUSE AND EXPLANATION

During the heyday of Processualism, discussions of cause and explanation in scientific archaeology focused on universal laws, single causes, and the Deductive-Nomological model of explanation (Binford 1968, 1977; Watson et al. 1969, 1984). This structure, however, has not survived. Due in part to the post-processual critique, the purported objectivity associated with cause and explanation has shifted to more contingent and subjective structures for understanding the human past (Fogelin 2007; Hegmon 2003; Kelley and Hanen 1987; Wylie 2002b). These shifts, however, do not make science passé or imply that discussions of cause and explanation are no longer relevant to the discipline. Revisiting these epistemological concerns is appropriate, especially in light of our goal of presenting and assessing current knowledge.

Cause and explanation address both how and why questions (Dunnell 1982, 1989). These questions are the scaffolding that supports cause and explanation, involving different causal mechanisms and different explanatory scales. How questions address process, or those steps, feedbacks, and interactions that result in one or more consequences. Answering why questions, however, requires variables external to the subject of explanation itself. Although process can be part of explanations addressing why, how questions need not include why.

Take, for instance, the depopulation of the Colorado Plateau in the thirteenth century. If we want to know why this abandonment occurred, then investigating climate, precipitation patterns, and intergroup aggression must be considered. By contrast, asking how abandonment occurred involves issues such as abandonment

rate, group sizes, and routes taken—all factors internal to the process. As another example, social networks may be causal in the distribution of certain artifact types during one or another time period. If this is the case, then investigating how social networks work is essential to explaining the distributions. If, however, the goal is to explain why such networks form, rather than their functions, then causes of their formation must be investigated. How social networks function cannot explain why social networks form. We need other mechanisms to avoid circularity.

As the examples make clear, there are no single causes. Instead, there are many causes that vary with the kind of question asked and that are framed in terms of research goal and scale. Research goal establishes what we want to know; functioning like a zoom lens, scale is the scope or inclusiveness of that goal. Accordingly, our investigations can expand or contract along one or more dimensions, including time and space. As a result, stipulating an appropriate cause at one scale becomes inadequate at a different scale.

As our understanding of causal scales has become more sophisticated, so too has our knowledge of adequate explanations. Explanations are inferences. There is a “best” explanation in a particular context, but to select among explanatory options, or “multiple working hypotheses” (T. C. Chamberlain 1890), involves a set of standards against which these competing inferences are judged. Standards include evidence, modesty, generality, simplicity or parsimony, refutability, testing, and conservatism. Even then, no explanation is final. The best explanation is likely to shift as we accumulate new evidence, as our understanding becomes more inclusive, or as explanations require fewer assumptions (Fogelin 2007). Creating these inferences is a process that Alison Wylie (2002a) describes as “archaeological tacking,” or moving intellectually between the theoretical and the concrete.

Relevant here is whether or not this understanding of inference excludes interpretation, defined as relative or subjective understanding of the past. Are explanation and interpretation mutually exclusive? Much archaeological ink has been spilled over this issue (Hegmon 2003; Hodder 1991; Preucel and Hodder 1997; Preucel 1989; Shanks and Hodder 1998; VanPool and VanPool 1999), and we do not provide a final answer to that question. More conservatively, however, because interpretation is also an inference, it can serve the same function as explanation so long as the same criteria of “best” are applied.

Cause and explanatory or interpretative inference, then, are concepts framed in terms of how or why questions that structure and facilitate understanding the archaeological record. Significant here is the integration of the three themes into this conceptual framework. In the following section we explore the ways cause and explanation are treated within each of the three topics.

CAUSE AND EXPLANATION IN HISTORICAL ECOLOGY, DEMOGRAPHY, AND MOVEMENT

Historical Ecology is an interdisciplinary paradigm that subsumes many disciplines, including cultural and human ecology, cultural and historical geography, anthropology, archaeology, environmental history, and landscape ecology (Denevan 2006). Uniting all these disciplines is the strongly held assumption that humans are inextricably tied to the landscapes they inhabit, use, modify, and leave (Balée and Erikson 2006; Denevan 2006; Kintigh et al. 2014; Mann 2011). Although change results from the interaction of humans and landscapes, cause and explanation can be weighted in terms of either variable. The difference between these kinds of cause was recently dramatized by the debate regarding the causes of cultural collapse on Rapa Nui. Whereas Jared Diamond (2006) made humans causal in the ecological suicide of Rapa Nui, Terry Hunt and Carl Lipo argued that the Polynesian rat was the principal source of deforestation and environmental degradation (Hunt and Lipo 2011). Although ancestral Polynesians introduced the rats to Easter Island (making humans part of their own demise), there were unintended consequences. Without competitors or predators, and with abundant trees, the rats rapidly proliferated, destroying their own resource base and ultimately causing soil degradation and cultural collapse.

Human impact studies of subsistence regimes that range from foraging to intensive agriculture often consider both how and why (Broughton et al. 2010; Campbell and Butler 2010; R. M. Dean 2010; Erlandson et al. 2008; Thompson and Waggoner 2013). Asking why, for instance, small fauna increases in late Hohokam villages, Rebecca M. Dean (2010) infers that the process of agricultural intensification, especially canal irrigation, had the unintended consequence of increasing forage for small mammals and birds.

In quite a different study involving foragers, Sarah K. Campbell and Virginia L. Butler found troubling the inconsistent assumptions regarding resource abundance, resource intensification and depression, prey species survival, and social complexity on the Northwest coast (Campbell and Butler 2010). In an earlier study (Butler and Campbell 2004), they had documented the stability of salmonids through time. Using those results as a baseline, they asked why and how these populations were sustained despite increasing subsistence pressure from growing human populations. The how became an investigation of deliberate and sustained habitat management for plants. In the end, optimal prey species were sustained through resource diversification, making the classic North American foragers also cultivators.

As suggested by the above examples, human population sizes, densities, and distributions are significant components in historical ecological explanations. Human demographic questions, however, need not be tied or limited to historical

demography. Demography is a crucial causal variable in all archaeological narratives (Kintigh et al. 2014) or explanations, and in the structure of this volume, it bridges the other two topics. People impact their environment and people are ultimately responsible for the movement of material, whatever the proximate cause.

The discipline of demography is a descriptive science and, at its minimum, addresses the size and structure of a population (the number of males and females in various age categories) (A. Chamberlain 2006; Cook and Borah 1971; Hassan 1981; Weiss 1973). Metrics such as life expectancy, number of live births per female, mean age of death, and health status expand the descriptions. Causal explanations of demographic change are lodged in the theoretical structure of the field and, classically, include three variables acting singly or in combination: increases or decreases in fertility, mortality, and migration. Obviously, these variables are related. When a population is declining over some period of time, emigration of females of child-bearing age could result in fewer births and fewer children. On the other hand, if a population is increasing, the causes could be immigration or capture of those same females, a decrease in the birthing interval, a decrease in childhood mortality, increasing life span, or a combination of all factors. Why a demographic structure changes requires consideration of external causes.

Infectious disease introduction to Pueblo peoples in the Southwest in the early colonial period exemplifies the difference between how and why. There is no question that Pueblo peoples declined in the wake of Spanish contact (Palkovich 1985b; Spicer 1962). As they migrated into the Southwest, Spaniards could have initiated the process of disease introduction that resulted in unexpected consequences, including diffusion of pathogens through native channels. Acute infectious diseases, hitchhikers on Europeans, then became the why of decline, as these unfamiliar pathogens were transferred to immunologically naïve Pueblo peoples. The issue is whether or not such massive disease sweeps occurred in the sixteenth century. Not surprisingly, there continues to be debate on this issue (Barrett 2002a; Dobyns 1983; Ramenofsky 1996; Ramenofsky et al. 2011; Ramenofsky and Kulisheck 2013; Schroeder 1968; Thornton 2000; Upham 1992). The most recent archaeological investigations suggest that, despite the Spanish presence, the infectious agents were not a sixteenth-century introduction. Pueblo peoples were stable demographically until the middle of the seventeenth century.

Addressing cause and explanation in movement studies is the most complex of the three themes in the symposium. First, there are two explanatory scales in movement studies that can be challenging to disentangle. Because people are the primary agent of the accumulation, distribution, and abundance of artifacts, how questions typically address one or more proximate causal mechanisms—for example, migration, exchange, intermarriage, or emulation. Why questions, by contrast, address

the external causes of the social processes, such as risk aversion through intermarriage or outmigration or the formation of networks. Why, for instance, is intermarriage the dominant process at one time while migration on a larger scale dominates at another?

The difference between the fine grain of behavioral causes and the coarse grain of the archaeological record makes equifinality a complicating factor in constructing explanations of movement. Archaeological studies of movement must begin with artifacts and with their geographic or geological source increasingly identified through high-resolution instrumentation. This initial focus on artifacts is, of course, essential because we need to know what before addressing how or why. Once distributions are known, how kinds of questions that address the processes by which the material culture moved become important, including exchange of objects, sharing of ideas, intermarriage, and migration. Due to this focus on material culture, investigation of what constitutes a meaningful pattern, and how that pattern develops, provides rich and humanistically interesting narratives that are inferences. Our difficulty comes in evaluating alternative narratives against the standards of evidence, parsimony, and refutability. This evaluation often leaves the problem of equifinality unaddressed.

Stubborn equifinality issues vex archaeological studies of movement in many geographic areas and are not unique to the Southwest. One long-standing debate from the south central Andes of Bolivia and Peru concerns how hallmark material culture (burial customs, ceramics, and other artifacts) from the Altiplano center of Tiwanaku appeared in the Moquegua Valley 300 kilometers to the southwest. The explanations proposed can be broadly categorized as either top-down or bottom-up social processes. The top-down explanation sees a controlled migration imposed by a ruling elite in the capital of Tiwanaku (Kolata 1993; Ponce Sangines 1972), while the bottom-up explanation sees an agent-based diaspora (Goldstein 1989a, 2000, 2005; Owen 2005) that occurs without the direction of a ruling elite.

In an effort to identify the origin of the Moquegua Valley population, researchers have undertaken a diverse range of studies. Included here are a variety of material culture studies (Goldstein 1989b, 1993; Janusek 2002, 2004); a study of mortuary patterns (Goldstein 1989a); skeletal analyses, including biological distance (Blom 2005; Blom et al. 1998) and skeletal modification isotope analysis (Knudson et al. 2004); and DNA studies (Lewis et al. 2007). The results have shown increased contact and genetic relatedness between the Altiplano and Moquegua populations during the zenith of the Tiwanaku polity. Notwithstanding this rich body of data regarding the identity of these people, the question of the causal social processes at work remains ambiguous. Here, as in many southwestern movement studies that involve multiple levels of analysis on a number of material classes (e.g., Ferguson et

al., this volume; Huntley et al., this volume), researchers search doggedly for independent tests to resolve the how questions but find that resolution elusive. Part of the difficulty in identifying the particular social process behind the movement of material traits is that why questions that address external causal factors have not been as intensively investigated as those internal to it.

In the Southwest, Patricia L. Crown's seminal work on Salado polychromes demonstrates the complexity involved in separating movement of things and ideas from the movement of people (Crown 1994). In this study she documents significant regional variation within the Pinedale Style. Although there are clear regional variations in the local expression of the Pinedale Style horizon (e.g., on Rio Grande Glaze Wares, Zuni Glaze Wares, etc.), she argues convincingly that these different archaeological ceramic types were painted in this style (see Carlson 1970). Its movement is tied to the spread of a difference-masking regional cult during the tumultuous 1200s and 1300s. The explanation is tied to population movements of unspecified scale that would have necessitated and facilitated integration of diverse populations into single communities (for a specific example of such integration, see Huntley et al., this volume). The mechanisms of spread—such as migration, intermarriage, or emulation—are not directly addressed in her study, but subsequent studies have endeavored to tease apart these mechanisms (e.g., chapters in Habicht-Mauche et al. 2006). In addition to the mechanisms of how, we might also ask why the strong stylistic similarities among early Zuni, Acoma, and Rio Grande glaze wares diverge after a relatively short time and emphasize different components of the Pinedale Style. Scott G. Ortman's study of Tewa origins (Ortman 2012c) develops a methodology by which these questions can be addressed, and it integrates external factors such as environmental conditions and demography with social processes.

To this point, we have adopted a broad view of the volume themes. We have shown that knowledge building through causal explanations is richly represented in each theme and that together and separately the explanations have contributed substantially to our global understanding of the human past. When viewed through the lens of cause and explanation, it is clear that all causal factors can become explanatory variables both with and across topics, with unintended consequences beyond the particular case. As populations migrate, for instance, artifact distributions change; new technologies, resources, and styles may be introduced and can result in innovation, emulation, and exchange. Those same populations, however, can become tipping points between subsistence resources and people, triggering still other long-term effects, including deterioration in human health, social conflict, or further migration.

This discussion has also been essential for situating the individual sections in a larger framework. We now introduce these sessions, highlighting how the session

leaders approached their topics. Table 1.1 summarizes the organization of the volume by topic, geographic areas, and time periods represented.

HISTORICAL ECOLOGY

Ronald H. Towner uses Carole L. Crumley's definition of historical ecology (Crumley 1994) as the interaction between humans and their environment. Because southwestern archaeologists have long been invested in explaining this interaction, Towner perceives close connections between the traditional southwestern focus on human-landscape interactions and the more recent development of historical ecology. In the Southwest the investigations of human-landscape interactions extend back to the early twentieth century (Antevs 1955; Douglass 1929), providing a well-developed knowledge base for more current explorations.

Towner examines the environmental-human interface through the lens of extreme events, those occurrences throughout prehistory and history that correspond to Jeffrey S. Dean's "episodic factors" (J. S. Dean 1996, 2006). He carefully differentiates events that are extreme from those that are rare. Rare events are defined by their periodicity. Although extreme events are, by definition, rare, they are defined by their magnitude. These unusual and unpredictable events can be causal factors in Towner's framework. They address the whys of changes in biota (including humans), the physical environment, and cultural traditions.

Despite their significance, extreme events pose challenges for archaeological investigations. Because they are unpredictable and sometimes unique, these events do not necessarily leave a definable archaeological trace. Moreover, and for exactly the same reasons, cultural responses to extreme events are not likely to pattern out uniformly. Consequently, we cannot predict, for example, that extremes in precipitation always result in the same cultural response. Contingent on previous histories, as well as other factors, extreme climatic events could result in migration, system collapse, or coalescence.

These concerns notwithstanding, the three chapters in this section are clear and unambiguous explorations of the interactions between extreme events and cultural traditions. Mary M. Prasciunas, Vance T. Holliday, and Jesse A. M. Ballenger review the Clovis-Folsom continuum in the Southwest in light of the Younger Dryas Climatic Interval. Although this climatic interval has long been considered causal in the change in land use from Clovis to Folsom, the authors cogently elucidate that the connections between the Younger Dryas interval and humans are correlations, not causes. They discuss the assumptions driving the correlations and identify problems in attempts to link the climate record and archaeology. In the end, Prasciunas and colleagues argue that the Younger Dryas interval still has

TABLE 1.1. Organization of this volume

<i>Chapter</i>	<i>Authors</i>	<i>Geographic area</i>	<i>Time period(s)</i>
2	Ronald H. Towner	Overview, Historical Ecology	
3	Mary M. Prasciunas, Vance T. Holliday, and Jesse A. M. Ballenger	Arizona, New Mexico (data by counties)	Paleoindian 13,500–11,700 BP
4	Mark D. Elson, Michael H. Ort, and Kirk C. Anderson	Northwestern Arizona (Arizona Strip, Flagstaff)	AD 1025–1200
5	Emily Lena Jones	Northern New Mexico (San Juan Basin, Picuris), central New Mexico (Salinas)	Colonial New Mexico, contact era (ca. AD 1630–~1790)
6	Jeremy Kulisheck	Overview, Demography	
7	Scott G. Ortman	Southwest Colorado, northwest New Mexico, Northern Rio Grande	AD 800–1700
8	Ann L. W. Stodder	Southwest Colorado, Galisteo Basin	AD 750–900, AD 1300–1680
9	Kathryn A. Kamp	Northern Southwest	Prehispanic Pueblo (AD 700–1600)
10	B. Sunday Eiselt and J. Andrew Darling	Northern New Mexico (Rio Chama)	AD 1700–1900
11	Severin Fowles	Northern Rio Grande (Taos)	AD 1030–1320
12	Deborah L. Huntley	Overview, Movement	
13	Sharon Hull, Frances Joan Mathien, and Mustafa Fayek	San Juan Basin (Chaco Canyon, Aztec, Salmon Ruins)	AD 1000–1280
14	Jeffrey R. Ferguson, Karl W. Laumbach, Toni S. Laumbach, Virginia T. McLemore, and Stephen H. Lekson	Southwestern New Mexico (Cañada Alamosa)	AD 700–1400
15	Erik Simpson	Northern New Mexico, southern Colorado (Upper San Juan)	AD 700–1300
16	Deborah L. Huntley, Jeffery J. Clark, and Mary Ownby	Southeastern Arizona, southwestern New Mexico (Upper Gila and Mimbres)	AD 1300–1600

explanatory power in addressing changes from Clovis to Folsom but that the exact causes remain elusive. In the chapter by Mark D. Elson, Michael H. Ort, and Kirk C. Anderson, the volcanic eruptions of Sunset Crater and Salt Springs are extreme events. Importantly, because the nature of the two eruptions was different, cultural

responses of regional populations were also different. This chapter thus clearly demonstrates the absence of uniform cultural response even to the same kind of extreme event—volcanic eruptions. The last chapter in this section, by Emily Lena Jones, examines Spanish migration and colonization in the Southwest as an extreme event. Her focus is on introduced fauna, especially livestock, and the consequences of those introductions on autochthonous species abundance in relation to Pueblo subsistence regimes. Using concepts of resource depression and rebound from Optimal Foraging Theory, Jones used multiple archaeofauna data sets, demonstrating rebound in higher ranked prey (large artiodactyls) following Spanish migration. Hypotheses to explain the rebound are many, including increased sedentism; local or regional abandonment and/or mortality; new technologies, including the horse; or new economic pursuits, such as Spanish demands for hides.

Demography

Population issues, including estimates of size, organizational structure, relative health, and change, are long-standing concerns to southwestern archaeologists (Bandelier 1890–1892; Crown 1991; Crown and Kohler 1994; Lycett 1989; Plog 1975; Ramenofsky et al. 2009; Schroeder 1992; Spier 1917, 1918, 1919; Upham 1992). These concerns, as Jeremy Kulisheck points out, are a function of several variables unique to the Southwest, including the intensity of regional archaeological research in the region; the relative integrity of the archaeological record due, in part, to the large tracts of land under state and federal control; and the high precision dating of dendrochronology.

Kulisheck provides a broad and insightful introduction to demographic archaeology that supports five equally broad chapters. Crucial to the entire section is the seminal distinction between *population* and *demography*. Although the terms are tightly connected and used interchangeably in publication, population and demography are different concepts—different aspects of the people equation (A. Chamberlain 2006). Population simply refers to the numbers of people at various spatial scales. Beginning with Raoul Naroll's ratio of people to space, southwestern archaeologists have expended considerable effort in exploring, modifying, and changing the equation that links to the two variables (Casselberry 1974; Dohm 1990; Kulisheck 2003, 2005; LeBlanc 1971; Naroll 1962; Nelson, Kohler, and Kintigh 1994; Plog 1975; Ramenofsky et al. 2009). Although demography also begins with numbers of people, it goes deeper, elucidating the composition of a population by age, sex, and, if available, reproductive history. These parameters are estimated through census data, archival documents, and skeletal populations.

With this essential distinction clarified, Kulisheck turns his attention to a consideration of the causes of demographic change. As described earlier, the causal variables

include changes in fertility, mortality, and migration. To this suite, Kulisheck adds identity, both as the process of self-identification among current populations and the important concept that archaeologists use to link material traits and ethnic units. Archaeological inferences about identity are frequently linked with migration through the analysis of artifact technologies and styles that differentiate immigrants from indigenous populations (see section 3 in this volume).

The five chapters in this section highlight different parts of demographic theory. Chapters by Scott G. Ortman and Severin M. Fowles focus on the issue of population numbers. Ortman sees continuing effort to improve the precision and accuracy of actual population numbers as essential for intellectual growth, supporting that position with specific suggestions and examples from the Southwest. Fowles implores us to move beyond the preoccupation with population numbers and argues that models, especially scalar stress models, fall far short. Using the long research history from T'aitōna (Pot Creek Pueblo) as a baseline, Fowles argues that the incorporation of ethnohistory and oral history into archaeological narratives provide a more complete understanding of T'aitōna population trends and abandonment than do scalar stress models. Ann L. W. Stodder's chapter addresses the challenge of quantifying ill health and chronic disease and their impact on prehistoric communities. She presents two contrasting cases (San Cristobal and Ridge Basin), employing disability weight metrics from the World Health Organization's Global Burden of Diseases, Injuries, and Risk Factors (GBD) program. The study shows the value of incorporating paleoepidemiological data in the consideration of population movement and demography. The emergence of *Vecino* identity in late eighteenth- and early nineteenth-century New Mexico is the key concern in the chapter by B. Sunday Eiselt and J. Andrew Darling. Ross H. Frank's (2000) economic model of Vecino ethnogenesis is the backdrop of their investigation. Using historical demographic estimates and land grant data, they show the shift in Vecino identity from one based on the *Casta* system to one based on the property. Maternal health and child survival are obvious variables to all considerations of demographic change or stability, but in archaeology they are glossed over or embedded in many larger explanatory structures. Kathryn A. Kamp sets out to change this oversight. In her contribution, she analyzes the role of both maternal health and child survival using a costs-benefits, risk-management model. Her discussion makes apparent that agency as family planning was likely practiced in the prehistoric Southwest and is certainly worthy of greater analytic investment by archaeologists.

Movement

Deborah L. Huntley's framework for movement studies is built on a foundation that begins with material culture traits rather than the causes of population movement,

as was the focus of the 2008 Southwest Symposium section on movement (Ortman and Cameron 2011). Giving primacy to material culture traits has unexpected consequences. It expands the possible social processes—how kinds of questions—that are proximate causes in movement. Did people move, and if so, what was the nature of the movement? Did objects move through exchange, trade fairs, or intermarriage? Or are the artifacts the product of shared ideas that resulted in emulation? Huntley explores each potential process and then adds finer discriminations. Included here is the scale of movement, separated into temporal, quantity, and distance; logistics of movement, meaning the organization responsible for movement; and context or value of the transmitted items or knowledge. If population movement is causal in artifact distributions, was the movement short- or long-term, of proximate or great distance, and was the process of movement gradual or rapid? A second consequence of the artifact focus is the tie between causes of movement and Kulisheck's demographic discussion of identity and migration. Migration is a cause of demographic change, and assumptions about material culture styles and technology are employed to identify the migrants.

Much of the introductory essay considers the inferential steps that connect artifact distributions to movement. Of key importance here are identifying geographic source locations and geochemical groups of artifacts, a research arena in which southwestern scholars have always been at the forefront (e.g., Abbott 2000; Crown 1994; Glascock et al. 1999; Glowacki and Neff 2002; Habicht-Mauche et al. 2000; Huntley et al. 2007; Shackley 1988; Shepard 1942; Warren 1979). As Huntley details, a suite of methods exists for addressing the provenance of materials. Provenance studies that employ chemical characterization or mineralogical analyses are direct methods (Harbottle 1982; Wilson and Pollard 2001). Indirect methods that consider shared technological styles are also employed, especially social networks (Habicht-Mauche et al. 2006; Lechtman 1977). As demonstrated in some of these chapters, combining technological style with chemical characterization can suggest when style sharing is emulation, exchange of various sorts, or population movement (cf. Shepard 1956).

The four case studies in this section provide wide spatial coverage, including the Upper Gila/Mimbres (Huntley et al.), the lower Alamosa (Ferguson et al.), the Upper San Juan (Simpson), and Chaco Canyon (Hull et al.). Although there is some duplication in the kinds of artifacts analyzed, explanations accounting for the movement of material are variable.

Erik Simpson's analysis of ceramics and architectural styles from a 600-year period in the Upper San Juan presents compelling evidence that the autochthonous populations were deeply conservative. Situated spatially between Chaco and Mesa Verde, these populations actively resisted being pulled into the vortex of

either system. The chapter by Jeffrey R. Ferguson and colleagues employs ceramics (both style and provenance), architectural elements, and obsidian provenance from Cañada Alamosa in their analysis of approximately 700 years of artifact movement. They demonstrate that explanations of patterns in one material class during one temporal interval are insufficient for addressing the same material at another time, or a different material class, but that different kinds of movement are indicated at different times, including migration, abandonment, down-the-line exchange, and intermarriage. The chapter by Huntley, Jeffery J. Clark, and Mary Ownby explains movement and change of ceramics, architecture, and obsidian following the Kayenta migration into the Upper Gila/Mimbres region using provenance data from decorated ceramics. Despite the uniformity in the origin of immigrants, two types of post-migration communities emerged: coalescent communities and communities in diaspora.

Sharon Hull, Frances Joan Mathien, and Mostafa Fayek consider movement of turquoise within the Chacoan world. Using stable isotopes and secondary ion mass spectrometry (SIMS), they document a great geographic range in source locations, from California to New Mexico. Although limited by the sample size of sourced turquoise artifacts, the diversity of source locations suggests a number of explanatory mechanisms that include direct procurement and a variety of trade structures and networks.

CONCLUSIONS

In the end then, the chapters in this volume consider both how and why questions. The historical ecology chapters focus on why; the demography and movement chapters consider how populations change and how artifacts move. As a result of these concerns, all participants are assessing the status of current and past knowledge. There are, in addition, other contributions, including unexpected theoretical correspondences, discussion of new methods, large-scale spatial investigations, and calls to reinvest our substantial intellectual capital in improving our measurements. Jones and Kamp frame their investigations with behavioral ecology models. Identity and history play significant explanatory roles in the papers by Kulisheck, Eiselt and Darling, and Fowles. Hull and colleagues present a new method for sourcing turquoise that will be invaluable in disentangling the geologically and socially complex question of Chacoan turquoise procurement. Stodder's use of the WHO GBD provides a new pathway for incorporating chronic diseases into archaeological descriptions and explanations of health. Ortman issues a clear road map for archaeologists to develop demographic estimates expressed in real numbers that are particularly significant to questions of migration and historical

ecology. Finally, all the contributions are clear demonstrations that archaeological knowledge in the Southwest continues to expand in directions that could not have been predicted fifty years ago.

Historical Ecology in Southwestern Archaeology

Long-Term Change and Extreme Events

RONALD H. TOWNER

Studies of human-environment interaction in southwestern archaeology have a long history. Beginning with Andrew E. Douglass's "bridging of the gap" (Haury 1962; Nash 1999) and his suggestion that the depopulation of the Four Corners region may have been related to the Great Drought of AD 1276–1299 (Douglass 1929), southwestern archaeologists have long debated the role of environmental variability in cultural change. Through various theoretical paradigms, including Julian H. Steward's (1955) Cultural Ecology (see also Rappaport [1968]; Sahlin [1964]), Processualism (Binford 1962; Clarke 1973; Renfrew 1987), and Karl Butzer's (1971) Environmental Archaeology, southwestern archaeologists have used the best paleoenvironmental and archaeological data in the world to address important questions about human-environment interaction (J. Dean 1996, 2000a; J. Dean et al. 1985), including the relationships between (a) post-glacial temperature change, megafauna extinction, and human predation (Ballenger, Prasciunas, et al. 2011); (b) alluvial water tables, human population densities, and the transition to agriculture (Antevs 1955; Irwin-Williams 1973); and (c) precipitation variability, soil productivity, and human migration and settlement mobility (Varien 1999a; Varien et al. 2007), to name just a few. The chapters in this section continue that long tradition and relate their research to the broader themes of migration, demography, and social interaction.

One of the most important tasks for southwestern archaeologists has been, and continues to be, identifying the links between environmental changes and cultural transformations at appropriate temporal and spatial scales. There are many

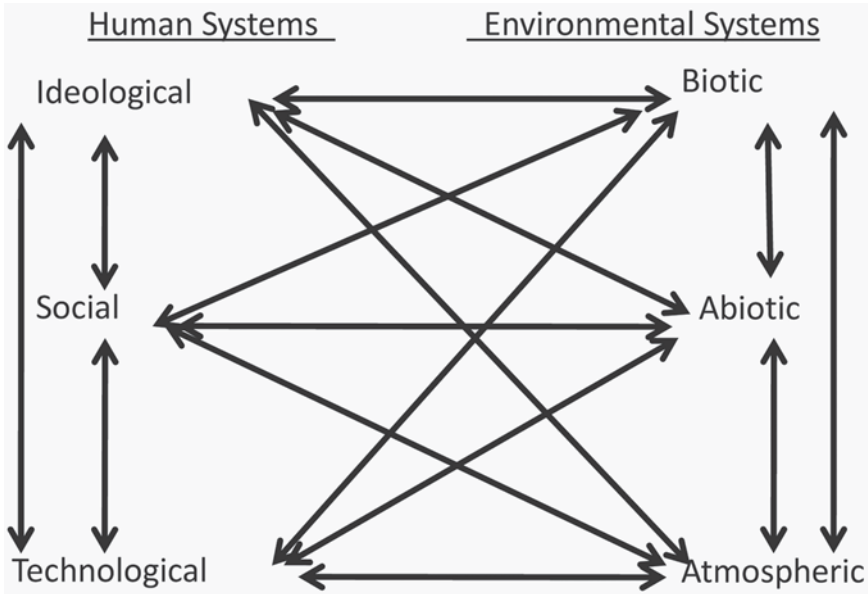


FIGURE 2.1. Human-environment interaction.

correlations between environmental and cultural change—the Great Drought and depopulation of the Mesa Verde area, the eruption of Sunset Crater and population movements in the Flagstaff area, fourteenth-century flooding on the Salt River and Hohokam decline in the Phoenix Basin—but temporal correlation is association; it is not cause. These environmental changes may correlate with cultural shifts, but the cultural shifts may have resulted from multiple causes—environmental and social.

Figure 2.1 summarizes my perspective on human-environment interaction. We can debate the divisions on either side; I use the Binfordian tripartite divisions simply as heuristic devices (Binford 1962). Every node on the matrix is connected to every other point in multiple ways, suggesting multicausal shifts. The matrix shows possible linkages, not directional causes. It is akin to systems theory (Wallerstein 1974) in that perturbations may begin at any of the nodes and impact the others. The system is not directed, neither is it static.

This structure is similar to Jeffrey S. Dean's (1996, 2006) detailed framework for the study of human-environment interaction, which assumes that (a) cultural and natural factors are both important in this type of study, (b) neither culture nor environment is stable, (c) culture and environment interact continually, and (d) cultures change in an attempt to achieve stability. Vast amounts of environmental data from geology, palynology, dendrochronology, and many other fields demonstrate

that the environment varies on different temporal and spatial scales. Perhaps the *key* assumption in studies of human-environment interaction is the concept that cultures change in an attempt to achieve stability. Such an assumption underlies much of classical systems theory. If that is indeed the case, long-term stability is never achieved because environments are constantly changing.

Within Dean's (2006) framework are important environmental concepts, such as low- and high-frequency processes, amplitude, and carrying capacity (Dean 1996, 2006). Carrying capacity is the number of people using a specific repertoire of technological and social systems that a landscape can support. Thus, environmental variability has a direct relationship to carrying capacity; changes in one direction or another limit (or not) the population that can be supported on a specific landscape with specific technological and social strategies. The environment varies at different temporal scales—from geological epochs to millennial, decadal, annual, and diurnal time frames. In terms of southwestern archaeology, important changes have occurred at all these scales. Dean (1996, 2006) discusses this variability—and cultural responses to it—in terms of low- and high-frequency changes and episodic factors. His primary assumption is that cultures primarily respond to low-frequency changes—those changes with a periodicity of greater than twenty-five years, or greater than a single human generation. High-frequency variations, with a periodicity of less than a single generation, may or may not generate a cultural response. Thus, studies of human-environment interaction must consider environmental parameters; cultural strategies such as population size, demography, and movement across a landscape; and technological sophistication (see Kulisheck, Ortman, Eiselt and Darling, Huntley, Simpson, and Huntley et al., this volume, for examples). Finally, his episodic factors are variations that have no known periodicity; they are, therefore, rare events, although they may not be extreme events. Rare events are simply that: events that occur so infrequently as to be outside collective human memory retention. Extreme events, on the other hand, are measured by their magnitude. If quantitative measurements are available, they are more than two standard deviations from some mean. Examples include droughts, floods, earthquakes, tsunamis, and even volcanic eruptions (Cooper and Sheets 2012). Other extreme events, such as severe but short-term cold spells, may not have quantitative measures, but they still may have impacted social groups in profound ways. The chapters in this section—and the entire volume—address various aspects of this model of human-environment interaction.

HISTORICAL ECOLOGY

In the past two decades, Historical Ecology has become an important paradigm in many areas, although its explicit use in the Southwest has been limited. Carole L.

Crumley defines Historical Ecology as the study of the history of human-environment interaction at multiple temporal and spatial scales, using multiple types of data from natural and social sciences and humanities (Crumley 2007). This definition is significantly different from others studying human-environment interaction in that it uses different types of data and the incorporation of different specializations.

Southwestern archaeologists, however, have long integrated a number of specializations and data sets into the study of human-environment interaction. Dendrochronology (Douglass 1929; Bannister 1962), alluvial stratigraphy (Antevs 1955; Haury 1957), palynology (Mehring and Haynes 1965), and packrat midden analysis (Betancourt et al. 1990) are only a few of the fields that have contributed significantly to understanding human-environment interactions in southwestern archaeology. In this sense, Historical Ecology is not new in southwestern archaeology.

Crumley maintains that the goal of Historical Ecology is to “use scientific knowledge in conjunction with local knowledge to make effective and equitable management decisions” (Crumley 2007:16). This approach implicitly, and often explicitly, involves the use of data from a variety of disciplines relevant to southwestern archaeology, such as paleoenvironmental reconstructions, settlement pattern analyses, ethnobotany, history, and traditional history. The difference, however, is Crumley’s explicit goal of using the results in management decisions and making policy. Southwestern archaeologists have long used such an approach, especially for the preservation of cultural resources (Lipe 1974). The passage of the Native American Graves Protection and Repatriation Act (NAGPRA) and the incorporation of Native American traditional histories and knowledge (e.g., Ferguson and Colwell-Chanthaphonh 2006; van der Leeuw and Redman 2002; Whittlesey, Ciolek-Torrello, and Altschul 1999) has increased the sophistication of archaeological explanations of human-environment interaction in the past two decades, thrusting archaeologists into the policy and management area beyond simply preservation of archaeological sites.

William Balée (1998), a major proponent of the Historical Ecology paradigm, developed “core postulates” (assumptions) in his research program, including

- Almost all environments have been affected by humans
- Humans are not genetically predisposed to lessen or augment species diversity
- Different kinds of societies impact the environment in different ways
- Human interaction with different environments over time may be studied as an integrative phenomenon

Although presented as groundbreaking, none of Balée’s postulates are new to southwestern archaeology. Southwestern researchers have been studying the

impacts of different types of societies on different environments over long and short time scales for decades (e.g., Euler et al. 1979; Ford 1984; Hack 1942; Haury 1967; Toll 1995). Crumley (2007), however, adds a significant political aspect—Applied Historical Ecology—with a goal toward influencing policy and management of resources and environments. Southwestern archaeologists have played important roles in the politics and policy development of historic preservation and cultural resources management legislation (e.g., Lipe 1974) but have been less involved in major environmental policy discussions and legislation. I believe this is a wise course of action. As a social science without definitive causal explanations for past phenomena, we risk our credibility as a discipline if we ally with so specific a political agenda.

One aspect of all of the new Historical Ecology permutations that seems missing or certainly downplayed is the role environment has played in human cultural trajectories. Human impacts on the environment, particularly modern impacts, have been discussed in detail (e.g., Redman et al. 2004), but the reverse is not as well discussed (but see Nelson and Strawhacker 2011; Nelson et al. 2012). This avoidance is probably due to the ghost of Environmental Determinism (Huntington 1915) looming over everyone's shoulder, but the role of environment cannot be denied. It may not be a proximate or even secondary cause in specific cultural trajectories, but environments certainly have a role to play. Elevation, soil type, precipitation, and temperature all influence plant and animal distributions—and thus human-environment interaction. Indeed, changes in climate seasonality may be a major catalyst for change (e.g., Dean and Funkhouser 1995).

Historical Ecologists have done an excellent service in dispelling the myth of the pristine environment (Balée 1998; Denevan 1992). There is no such thing, and there never has been. One of the fallacies of the twentieth-century environmental movement was the concept of “Eden unchanging” prior to the industrial revolution. As botanists and ecologists began to examine the idea of normal plant succession communities, they started to investigate the role of disturbance events and processes in ecological systems. Although ecologists were, and are, more concerned with events such as fires and floods (e.g., Swetnam and Betancourt 1998), humans are an important part of any environment and are disturbances—but they are not the only disturbance factor. Much of the recent Historical Ecology literature (e.g., Crumley 2007; Balée 1998) has examined how humans impact different environments. Equally important, however, is how human groups have responded to “natural” environmental changes. Such responses are most evident in the archaeological record as sudden shifts in demography, land use/settlement patterns, and/or subsistence. Obvious examples in southwestern archaeology include the depopulation of the Four Corners in the 1200s (Lipe 1995), the “demise” of

the Hohokam in the Phoenix Basin (Dean 2007; Haury 1976), and the abandonments of Pueblo villages along the lower Rio Grande in the historic period (Barrett 2002b; Kulisheck 2003).

A key term from Historical Ecology is *landscape*—as a physical and cultural construct. Landscape ecologists view noncyclical human events and natural disasters as external influences, while Historical Ecologists view disturbances as an integral part of the landscape's history. Extreme environmental events do not “reset the clock.” Landscapes have histories (Wagstaff 1987), but like all history, they do not repeat or restart themselves—they change trajectories.

This landscape approach allows archaeologists to examine human-environment interaction on multiple scales. Physically, we can draw lines on a map and conduct research in a confined area, such as Gordon R. Willey's (1953) Viru Valley study; but we can also look at the cultural landscape—the Puebloan world (Adler 1996), the Hohokam sphere (Fish and Fish 2008), and the Spanish colony (Barrett 2012), to name just a few. This is an important research agenda: examining culturally similar human groups exploiting many different econiches with diverse technologies and social organizations while living, dying, and moving around on a landscape not constrained by plant communities or lines on a map (Adler 1996). For example, the Formative Period in the Southwest has traditionally been divided into Anasazi/Colorado Plateau, Hohokam/Sonoran Desert, and Mogollon/mountain spatio-cultural groups (Cordell 1997). Yet within each of these broad divisions are smaller groups that responded to local environments—Mesa Verde Anasazi, Tonto Basin Hohokam, etc.—and changed over time in response to natural and anthropogenic-induced environmental variation. More recent research (Bernardini 2005; Woodson 1999; see also Huntley et al., this volume; Ferguson et al., this volume; Simpson, this volume), however, suggests that even the broad divisions were not static. Here, agency enters the picture: humans make choices that impact the landscape continually. It is also an area where the Southwest has abundant information in the form of oral histories from many descendent communities. Native traditions have described the eruption of Sunset Crater (Elson et al., this volume), they have illuminated aspects of the Kayenta migration from north-eastern Arizona to the Safford Valley (Colwell-Chanthaphonh 2003; Ferguson and Colwell-Chanthaphonh 2006; Huntley et al., this volume), and they have discussed the ethnogenesis of a people (Wilshusen 2010; Seymour 2012; Eiselt and Darling, this volume). Thus, southwestern archaeologists now have databases in archaeology, chronology, and paleoenvironment, and written and oral histories to delineate how humans impacted the environment and how they responded to both anthropogenic and non-anthropogenic landscape change.

EXTREME EVENTS

Disturbance factors bring us to the topic of Extreme Events. Extreme events are similar to Dean's (2006) "episodic factors" that have no known periodicity—a topic with a long history in archaeology and history. Southwestern archaeologists have identified megafaunal extinctions (Martin 1967; Martin and Klein 1989), droughts (Douglass 1929), floods (Graybill 1989), volcanic eruptions (Smiley 1958), and colonization (Simmons 1991) as extreme events in the Southwest, and this list may be limited only by our data sets. Events can be rare but not extreme, however; the former is a measure of periodicity, whereas the latter is a measure of magnitude.

Environmental parameters tend to delineate the physical nature of an event. Most relevant to southwestern archaeology are those of magnitude, duration, areal extent, and seasonality. Richard M. Reyecraft and Garth Bawden also include frequency and time of onset (time of day) (Reycraft and Bawden 2000b). These are less relevant to southwestern archaeology: the former, because events more frequent than a human generation are defined as high-frequency variation, and the latter, because it is not archaeologically detectable. Magnitude, particularly of droughts, is defined as greater than two standard deviations from mean conditions (Towner and Salzer 2013); by definition, such events are rare. Similar measures are used to identify extreme floods (Ely et al. 1993). Some events, however, such as volcanic eruptions, earthquakes, etc., have no mean conditions; therefore, they are defined qualitatively, such as areal extent. Areal extent is important to southwestern archaeologists, as it relates to different cultural groups. A high-magnitude event in a limited area, such as the Sunset Crater eruption, may have serious local consequences but may not severely impact larger cultural interaction spheres, trade networks, or overall population demographics. Event seasonality, if identifiable, may be critical for interpreting impacts on southwestern cultures, particularly Formative Period agriculturalists.

Reycraft and Bawden (2000b) list nine "social factors" in hazards mitigation that may be used to delineate the effects of extreme events: resource distribution, capital investment in resource distribution, level of technological efficiency, type of economic system, prior experience with event, population density, wealth, sociopolitical complexity, and areal extent of polity. These factors predominantly describe cultural organization and infrastructure; however, they are directly related to carrying capacity, something southwestern archaeologists can and have measured quite successfully. Factors such as population density, sociopolitical complexity, and technological efficiency are readily, but not easily, identifiable in the archaeological record. The impacts of extreme events, therefore, may be detectable via geophysical data but archaeologically should be most visible in responses by the organizational structure of past societies.

The most important issue in southwestern archaeology relative to extreme events is their identification. Can we identify such events environmentally and delineate their impacts culturally? I believe that the Southwest is one of the few areas of the world where we *can* conduct such research. We have the temporal control; environmental data; a highly trained cadre of archaeologists, anthropologists, ecologists, and historians; as well as excellent information through traditional histories—all of the components described by the proponents of the new Historical Ecology.

Some extreme events have been recognized in the archaeological record by their environmental attributes—volcanic eruptions by ash layers (Smiley 1958), floods by specific sediments (Ely et al. 1993), and droughts by small tree rings (Douglass 1929; Stokes and Smiley 1968). Such events have been linked to the major themes of this volume—human demography, migration, and movement (see Ferguson et al.; Huntley, Huntley, et al.; Kamp, Kulisheck, and Simpson, this volume). For example, Harold S. Colton (1932a, 1960) discusses changing land-use patterns and populations of the Sinagua in response to the eruption of Sunset Crater, the theme Mark D. Elson et al. explore anew in this volume. Likewise, Donald A. Graybill (1989) examines the relationships between flooding and the demographic collapse of the Hohokam system in the Phoenix Basin, and Richard V. N. Ahlstrom et al. posit a northwest-southeast environmental gradient that influenced Anasazi emigration from the Four Corners (Ahlstrom et al. 1995).

Other extreme events may leave few traces, however. For example, during mid-February 2011, a very cold polar front impacted much of the United States for two to three days. In the Sonoran Desert, this short-term event meant temperatures dropped to the high teens °F and severely impacted some vegetation types. Some flora recovered just fine—mesquite were a little late in leafing out but bloomed and grew well. The real impacts were seen in three plant types—two native and one introduced. Almost immediately, the large prickly pear cactus (*nopales*) lost major arms and sometimes trunks. Their typical desert adaptation is to store copious amounts of water in their pads, so when those parts froze, the weight was simply too much and substantial portions fell to the ground. Interestingly, some people scoured the area to recycle these pads—something of a bonanza. But many nopales also rotted on the ground for weeks. Within days, many of the Organ Pipe cacti turned purple, then brown, then white—dead. Many introduced citrus trees—a major part of the economy fifty years ago—froze. Those trees that survived had to be severely trimmed. The big freeze hit about two weeks before the harvest, and the 2011 crop was lost. Many severely pruned trees survived, but there was no time for leafing out, flowering, and setting fruit. The result was the additional loss of the 2012 crop. In the end, this very short-term extreme event meant (a) a severe decline in the productive capacity of nopales (no fruit in 2011, fewer small pads, and the death of a significant number

of cacti); (b) the loss of many Organ Pipe cacti (again, fewer fruit and plants); and (c) the total loss of two seasons' worth of citrus fruit in many orchards.

Could similar events have happened in the past? We know a similar event occurred in 1976 and is identifiable in southeastern Bald Cypress tree rings (Stahle 1990); but southwestern tree rings are much less sensitive to temperature. If such events occurred, what were the environmental and social impacts? What were the impacts to native food sources? And what were the impacts to domesticated crops—collectively and, probably more importantly, by individual species? And, to tie this into other themes in this volume, only two people died of hypothermia in Tucson in February 2011, but during that event, churches and other complex infrastructure provided support. Did such an event initiate the movement of people because of resource (food resources) destruction? Could it have initiated the importation of goods (foodstuffs)? How much do these impacts depend on the physical and social parameters of the area? These are questions that can only be addressed if the event and responses are identifiable in the archaeological record.

With these issues in mind, it is important to examine the archaeology of extreme events and delineate the events and their social consequences—always keeping in mind that we may have to work backward—looking at the social consequences to identify the *possibility* of an extreme event. Trying to explain a shift in cultural behavior by examining all the nodes and connections in the matrix above is not an easy task, but one that southwestern archaeologists have been working on for decades. I am certainly not advocating a return to Environmental Determinism but for an examination of many different data types to help explain various factors concerning past human movements, population trends, organizational trajectories, and environmental variability.

SECTION ORGANIZATION

The chapters in this section examine aspects of these factors, although not all factors are relevant to every situation. Each contribution uses multiple data sets from different disciplines to examine some aspect of human-environment interaction; more important, they also contribute to the themes of the volume—human demography, migration, and settlement pattern changes.

Mary M. Prasciunas, Vance T. Holliday, and Jesse A. M. Ballenger elucidate Clovis and later Paleoindian land-use patterns during the terminal Pleistocene and early Holocene. They suggest that models of spatial ecosystem changes may help explain the distribution of human populations during this time of tremendous environmental, ecological, and cultural change, unmatched in the last eight millennia. They also address ambiguities in the data. Different paleoenvironmental data sets indicate different directions of climate change—warmer and drier and cooler and wetter; thus,

interpreting paleoenvironmental data is not a simple task. Southwestern archaeologists have long been aware of formation processes (Schiffer 1987) and their effects on the archaeological record. Prasciunas and colleagues discuss site visibility and assemblage composition while assessing the assumptions that underlie large databases.

Mark Elson, Michael Ort, and Kirk Anderson compare two volcanic eruptions—certainly extreme events for the local populations in northern Arizona—and the different societal responses to each. Their refined dating of the eruption of Sunset Crater has important implications for models of population movements and pre- and post-eruption settlement patterns in the Flagstaff area and, by implication, population interactions across much of northern Arizona. Incorporating high-resolution temporal data, geochemical data, and traditional history into their research provides a model for Historical Ecology research relevant to interpreting land-use changes by Formative groups responding to extreme events.

Finally, Emily Lena Jones takes on the unenviable task of researching the undoubtedly greatest ecological transformation since the end of the Pleistocene: the introduction of a completely new set of fauna by the Spaniards and the changes that process wrought ecologically and in native subsistence economies, demography, social organization, and intergroup relations. Using zooarchaeological data from pre- and postcontact pueblos, missions, and Early Navajo sites, Jones discusses changing resource use as a consequence of social, cultural, and demographic factors. Although not strictly environmental, the intrusion of the Spaniards into the area was certainly an extreme event. At the same time, an overlay of high climatic variability may have also influenced faunal assemblage composition. Thus, her research is establishing a benchmark for examining southwestern cultural and environmental change using multiple faunal and other data sets.

As a whole, these chapters show the promise of Historical Ecology as a research paradigm: they use multiple data sets from the natural and social sciences and humanities to posit explanations of how humans in the Southwest have responded to changing landscapes—and how they shaped those landscapes—for thousands of years. These are long-researched topics in southwestern archaeology because the paleoenvironmental and archaeological data are unmatched anywhere in the world. They also show the need for incorporating many different data sets to address research questions from different perspectives. But, like all good research, the chapters raise more questions than they answer.

ACKNOWLEDGMENTS

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Terminal Pleistocene Paleoindian Ecology and Demography

A View from the Southwestern United States

MARY M. PRASCIUNAS, VANCE T. HOLLIDAY, AND JESSE A. M. BALLENGER

Human foragers first entered the North American continent at the end of the Pleistocene, a dynamic period characterized by major climatic, environmental, and ecological change. Although lively debate continues to surround many aspects of the colonization process, Clovis is still the earliest widespread and well-documented North American cultural complex, dating to approximately 13,500–12,800 cal BP (Taylor et al. 1996; Waters and Stafford 2007; Sanchez et al. 2014).

Clovis groups occupied the North American continent during the Bølling-Allerød interstadial, a period of rapid warming between approximately 14,600 and 12,900 cal BP, following the Last Glacial Maximum. The latest dates for Clovis fall within the Younger Dryas Chronozone,¹ a period of cooling temperatures in northern latitudes that occurred between approximately 12,900 and 11,600 cal BP (Björck 2007). The Younger Dryas is marked by evidence for changing climatic conditions in some parts of the continent and is frequently assumed to have been an extreme event (see Towner, this volume) that posed challenges for Paleoindian populations and their animal prey, ultimately causing significant demographic, cultural, and land-use change. For instance, Anderson et al. (2011:580) argue that the onset of the Younger Dryas resulted in major human population declines or reorganization across broad areas of North America. Similarly, Anderson and Faught (2000:512) have linked Younger Dryas cooling to regional abandonment, “the demise of the Clovis way of life, the emergence of subregional cultural traditions, [and] the extinction of the megafauna.”

The disappearance of Clovis from the archaeological record around the beginning of the Younger Dryas, along with the appearance of stylistically distinct and spatially restricted projectile point types thought to represent the beginnings of regional adaptations, seems to support the argument that broad cultural changes were triggered by Younger Dryas climate change. In the southwestern United States, for instance, and as noted more than forty years ago by Cynthia Irwin-Williams and C. Vance Haynes, the remarkably close coincidence between the beginning of the Younger Dryas and what appear to be major cultural, economic, and demographic changes that mark the transition from Clovis to Folsom, leads to the intuitively satisfying interpretation that Younger Dryas climate change was the causal mechanism partly responsible for these changes (Irwin-Williams and Haynes 1970).

At issue, however, is both cause and explanation (see Ramenofsky and Herhahn, this volume), because actually linking the dynamic climatic, environmental, and ecological changes that took place at the end of the Pleistocene with the transitions apparent in the archaeological record at that time is a complicated problem. Of primary importance is that terminal Pleistocene environmental changes appear to have varied in character, magnitude, and tempo across the globe (Shakun and Carlson 2010), as well as across North America (Meltzer and Holliday 2010). Inadequate temporal resolution, coupled with ambiguities in proxy environmental indicators and in the archaeological record itself, also preclude simple correlations between human behavior and environmental change. As Ronald H. Towner (this volume) notes, much of the recent historical ecology literature has focused on human impacts to environments rather than human response to environmental change. This chapter, then, is a departure in that it examines the many assumptions and ambiguities associated with the archaeological and paleoenvironmental records of the terminal Pleistocene, with the goal of clarifying the relationship between Younger Dryas climatic change and Paleoindian responses in the southwestern United States.

YOUNGER DRYAS CLIMATE CHANGE

The Younger Dryas, named for a cold-tolerant flowering shrub (*Dryas octopetala*) present in European macrofossil and pollen records, is often described as a pronounced reversal in the overall warming trend that characterized the terminal Pleistocene after the Last Glacial Maximum. The Younger Dryas was first recognized as an abrupt shift to cooler conditions in large parts of Europe (Björck 2007). Comparable climatic shifts were subsequently recognized in high-latitude North American lake cores, Greenland ice cores, and foraminifera sequences in North Atlantic deep sea sediments (e.g., Alley et al. 1993; Mayle and Cwynar 1995; Peteet

1995; Wright 1989), suggesting that cooling took place on a hemispheric, if not global scale (Broecker 1994; Hughen et al. 2000; Peteet 1995).

Although details remain unresolved, Younger Dryas climate change is thought to have been triggered by disruption of the Atlantic Ocean's meridional overturning circulation, brought about by an epic discharge of glacial meltwater (Alley 2007; Broecker et al. 1985, 2010; McManus et al. 2004). The clearest signal of Younger Dryas climate change comes from multiple proxy indicators from the Greenland ice cores, which record a mean annual Younger Dryas air temperature as much as 15–16°C colder than today (Denton et al. 2005). The Greenland ice core record has also allowed very precise dating of the Younger Dryas interval, indicating that its beginning and end were abrupt, perhaps occurring over the course of decades (Denton et al. 2010). However, Younger Dryas temperatures do not appear to have been cold year-round. George H. Denton and colleagues argue that Younger Dryas climate was instead strongly seasonal, with very cold winters and more mild summers over much of the Northern Hemisphere (Denton et al. 2005). In portions of the Northern Hemisphere, this pattern resulted in glaciers halting their retreat or even re-advancing (Dyke 2004).

Although the Younger Dryas cold event evident in ice core and botanical records has been detected across much of the Northern Hemisphere, it was largely centered in the North Atlantic, with other regions showing less abrupt, less significant, or simply different patterns of climatic change (Alley and Clark 1999). For example, Richard B. Alley (2007:247) notes a southward shift in tropical atmospheric circulation during the Younger Dryas, along with Southern Hemisphere warmth and unusually dry conditions in large areas of monsoonal Africa and Asia. David J. Meltzer and Vance T. Holliday review the climatic and environmental conditions of the Younger Dryas in North America, noting that there is little evidence that all of North America experienced cooling during this time (Meltzer and Holliday 2010). Patterns of temperature, precipitation, and vegetation response varied spatially and temporally; some areas of the southeastern United States and portions of the mid-continent east of the Rocky Mountains may have witnessed warm, temperate climates. More detailed regional reviews of Younger Dryas climatic and environmental change were recently provided for much of North America (e.g., papers in Straus and Goebel [2011]), further illustrating this inter- and intra-regional variability.

THE TERMINAL PLEISTOCENE ENVIRONMENTAL RECORD OF THE SOUTHWEST

Before we can discuss the possible responses of terminal Pleistocene foragers to climatic change in the southwestern United States, we need to first understand the

character, magnitude, and direction of Younger Dryas environmental changes in the region. Although there is a long history of paleoenvironmental research in the Southwest that has encompassed the latest Pleistocene and early Holocene (e.g., Antevs 1955; Martin 1963; Haynes 1968; Irwin-Williams and Haynes 1970; Van Devender and Spaulding 1979), continuous paleoenvironmental records that span the Younger Dryas are rare. Ballenger, Holliday, et al. (2011) recently reviewed multiple, age-resolved proxy evidence for paleoenvironmental changes in the Southwest during the Younger Dryas. This paleoenvironmental comparative summary includes data from various sources, including speleothem, packrat midden, and paleontological, palynological, and stratigraphic records of the region but derives largely from the Basin and Range province of southeastern Arizona and New Mexico, where research currently is being conducted, with high-elevation records from the southern Colorado Plateau and Rocky Mountains comparatively underrepresented.

In short, consensus is lacking as to the magnitude and direction of Younger Dryas climate change in the Southwest (Ballenger, Holliday, et al. 2011) as it is elsewhere (Meltzer and Holliday 2010). Speleothem records provide the best resolution and show isotopic oscillations coincident with the beginning of the Younger Dryas that are interpreted as reflecting a shift from warmer/drier to cooler/wetter conditions and/or increased winter precipitation (Asmerom et al. 2010; Wagner et al. 2010). The speleothem record is supported by pollen sequences that may indicate the transition from warmer/drier desert grasslands to cooler/wetter pinyon-juniper-oak woodlands during the early Younger Dryas (Mehring and Haynes 1965; Ballenger 2010b). Alluvial chronologies that indicate the activation of springs and black mat formation at the beginning of the Younger Dryas also support wetter conditions and/or less evapotranspiration (Haynes 2008; Pigati et al. 2009; Quade et al. 1998; but see also Holliday 2000; Meltzer and Holliday 2010). However, other important paleoenvironmental and paleohydrological records do not support cooler/wetter Younger Dryas conditions. Packrat middens, for example, show the loss of mesic pinyon-juniper woodlands through the Younger Dryas and increasingly dry conditions (Van Devender 1990a, 1990b), and none of the lake records in New Mexico or Arizona show Younger Dryas highstands (Ballenger, Holliday, et al. 2011).

These conflicting records have not been integrated to form a coherent model of terminal Pleistocene paleoclimatic and paleoenvironmental change in the Southwest. Significant and widespread paleoenvironmental changes coincident with the Younger Dryas are apparent, but the magnitude and even the direction of those changes are inconsistent between and sometimes within proxies. However, the best-resolved records do indicate cooler/wetter climates and/or increased winter precipitation in the northern Chihuahuan and Sonoran deserts during the Younger Dryas (Ballenger, Holliday, et al. 2011).

THE TERMINAL PLEISTOCENE ARCHAEOLOGICAL RECORD OF THE SOUTHWEST

Well-dated terminal Pleistocene sites in the Southwest are few. Clovis represents the earliest widely accepted evidence of human occupation in the region. Based on radiocarbon dates from the Murray Springs and Lehner sites in the San Pedro River Valley of southeastern Arizona, Clovis groups were in the Southwest around 12,800 cal BP (Waters and Stafford 2007). Folsom sites in the Southwest are also poorly dated, but in eastern New Mexico, Folsom occupations occurred at the Folsom site around 12,500 cal BP (Meltzer 2006) and at Blackwater Draw around 12,200 cal BP (Taylor et al. 1996). More broadly, Clovis dates range between 13,500 and 12,700 cal BP (Sanchez et al. 2014; Waters and Stafford 2007) and Folsom between 12,700 and 11,700 cal BP (Collard et al. 2010).

Plainview-Goshen and Agate Basin projectile point types have also been documented in the Southwest (Hedquist et al. 2011) and are radiocarbon dated to the Younger Dryas in other regions (Faught and Freeman 1998; Huckell and Judge 2006). However, the age range of these broadly defined types is uncertain, and they have not been found in dated contexts in the Southwest. Similarly, Western Stemmed (Lake Mohave, Silver Lake) type points span the Younger Dryas in the Intermontane West (Beck and Jones 2010) but are morphologically similar to early-middle Holocene types identified in the Southwest (Irwin-Williams 1973). In terms of a well-documented human presence in the Southwest during the terminal Pleistocene, then, this leaves us with Clovis representing human occupation during the Bølling-Allerød and Bølling-Allerød/Younger Dryas transition and Folsom representing human occupation fully within the Younger Dryas (see figure 3.1 for select examples of Clovis and Folsom points from the Southwest). Comparison of the Clovis and Folsom archaeological records should therefore be instructive in evaluating the impact of Younger Dryas climatic change on human behavior.

Regional reconstructions of Paleoindian land-use and settlement strategies are often based on rare sites that have received detailed study. However, a larger scale of analysis is perhaps more useful when evaluating broad trends in human land-use strategies through time. For this reason, we use Clovis and Folsom projectile point distributions across Arizona and New Mexico as indicators of population density and distribution in the Southwest before and during the Younger Dryas. However, while Clovis and Folsom projectile point distribution patterns provide an informative scale of analysis otherwise lost with a single-site approach, numerous assumptions and potential biases are embedded within this approach.

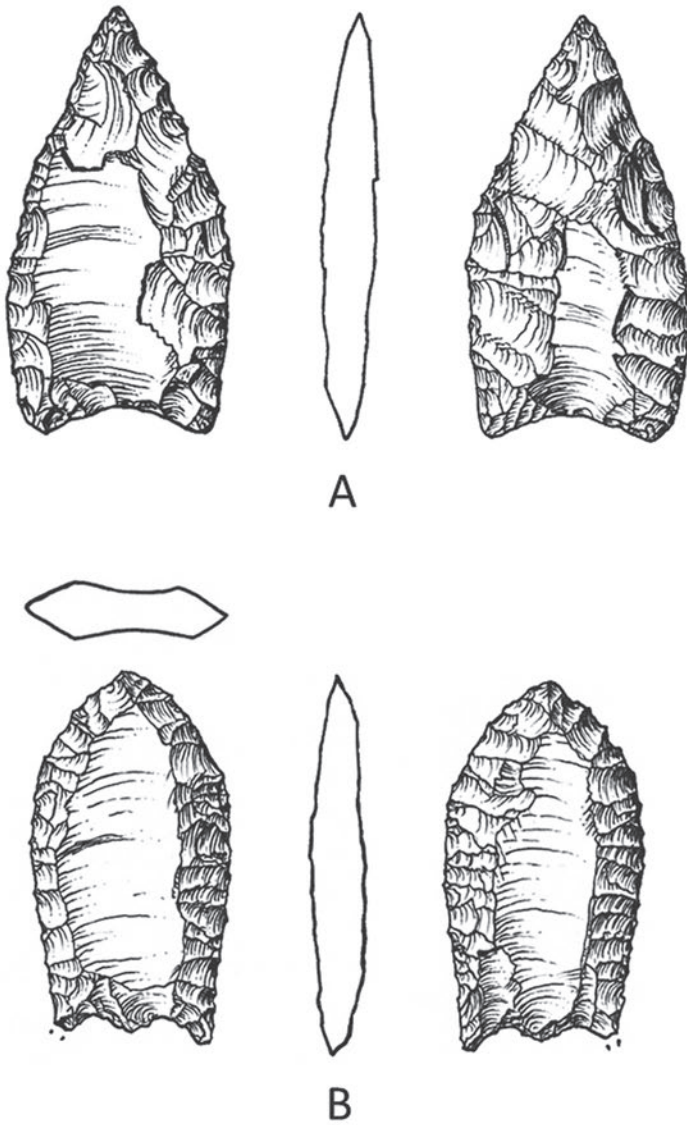


FIGURE 3.1. Examples of terminal Pleistocene Paleoindian projectile points from the southwestern United States.

Assumptions and Potential Biases

We assume that projectile point density and distribution patterns provide proxy indicators of Paleoindian population density and distribution. There are, however, many potential reasons why point distribution may not accurately reflect the distribution of prehistoric populations. Biases such as geologic visibility, modern population density, cultivated acreage, collector efforts, and intensity of archaeological research are undoubtedly operating to affect projectile point visibility, and so the patterns apparent in point distribution should be interpreted cautiously (Anderson et al. 2008; Prasciunas 2011). Mary M. Prasciunas (2011), for example, shows that the distribution of Clovis projectile points across a large portion of the United States is significantly related to modern population density, cultivated acreage, and intensity of archaeological research, suggesting that these variables are affecting Clovis point visibility. We assume, however, that any potential biases affecting point visibility would likely affect Clovis and Folsom point distributions in the same direction. For example, geographic regions with deeply buried terminal Pleistocene-age surfaces would obscure evidence for both Clovis and Folsom occupations equally. Similarly, if increased surface exposure (e.g., through cultivation) occurs in one region versus another, both Clovis and Folsom points would likely be exposed and collected, if present. Comparison between Clovis and Folsom point distributions should therefore still be meaningful for identifying relative differences in population density and distribution, at least in those regions where either Clovis or Folsom points are present. If neither is present in a particular region, however, then issues affecting visibility cannot be ruled out as an explanation for their absence.

A final assumption made by researchers who use projectile point distributions as proxy indicators of prehistoric population distribution and land-use patterns is that projectile points alone are capable of providing an accurate picture of prehistoric land-use strategies. If projectile points are hunting weapons employed in the pursuit of large grazers, as the regional archaeological record indicates, then projectile point distribution patterns tell us only about where Paleoindian populations lost or discarded hunting weaponry and not about where other activities may have occurred. Paleoindians were highly mobile foragers, and as Deborah L. Huntley (this volume) points out, there are many dimensions of movement. Although projectile points can certainly provide insight into Paleoindian mobility through raw material and artifact distribution studies (e.g., Amick 1996; Hamilton et al. 2013; Hofman 1991), a focus solely on projectile points will never be able to completely elucidate the undoubtedly complex landscape-use patterns of mobile foragers. Projectile points, however, comprise the only unambiguously diagnostic component of the Paleoindian toolkit, making surface finds of other Paleoindian artifacts difficult or impossible to definitively identify.

Clovis and Folsom Projectile Point Distributions

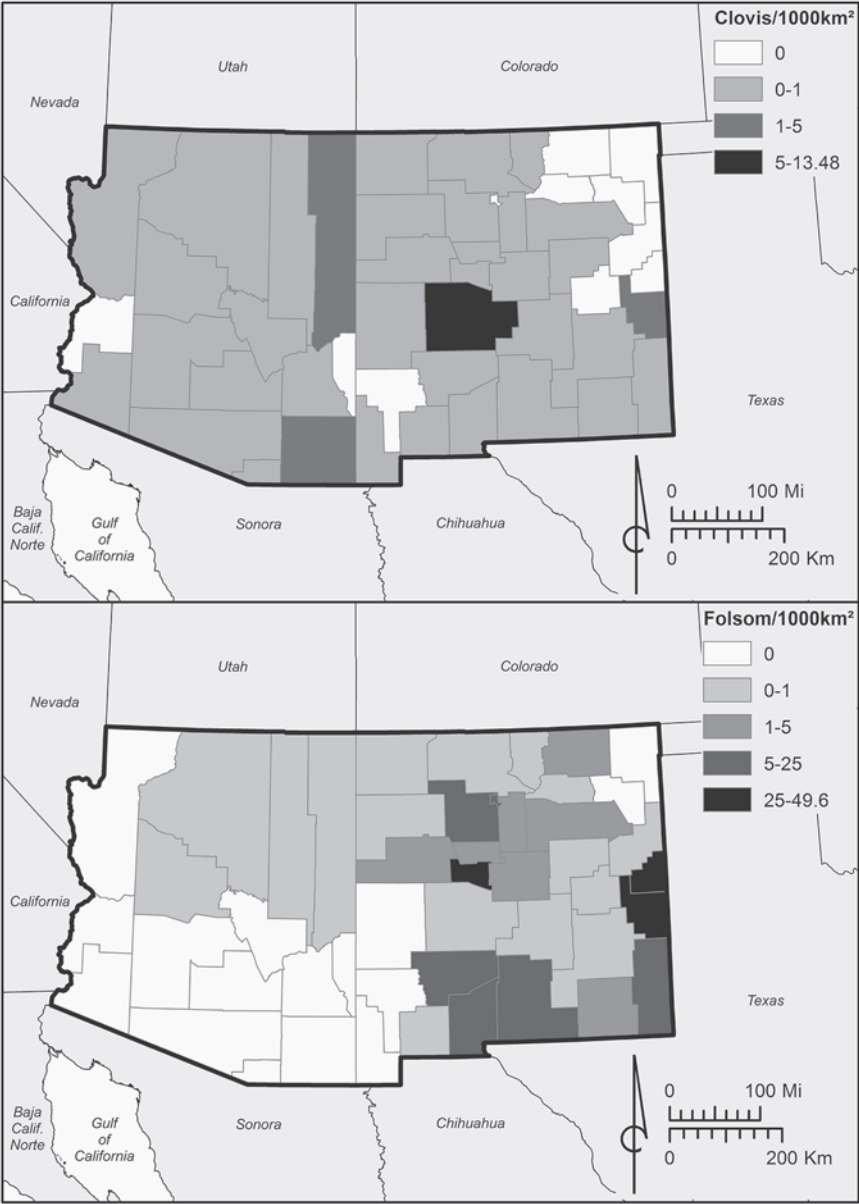
Map 3.1 shows the distribution of Clovis and Folsom projectile points in Arizona and New Mexico at the county level, with point densities shown per 1000 square kilometers. Projectile point distributions are based on the Paleoindian Database of the Americas data set (<http://pidba.utk.edu/main.htm>) (Anderson et al. 2010), with Clovis data supplemented by Haynes (2011), Prasciunas (2011), and the Arizona Paleoindian and Paleoarchaic Projectile Point Survey (<http://azpaleosurvey.pidba.org>). The Folsom data are supplemented by Daniel S. Amick and Amick and Paul D. Lukowski (Amick 2006; Amick and Lukowski 2006). Matthew E. Hill, Jr., and Holliday (2011) also provide Clovis and Folsom projectile point counts based on the collection of the late Robert H. Weber (Hill and Holliday 2011). These sources collectively resulted in a sample of 1,960 projectile points, including 109 Clovis points and 33 Folsom points from Arizona and 292 Clovis points and 1,526 Folsom points from New Mexico (Folsom and Midland projectile point types are considered the same techno-complex and referred to collectively as “Folsom” throughout this chapter).

Striking differences are indeed apparent between the densities and distributions of Clovis and Folsom projectile points across the study area (map 3.1). While Clovis points appear widely distributed, Folsom points are documented throughout most of New Mexico and northern Arizona but are excluded from the northwestern Chihuahuan and Sonoran Deserts. A Moran's I (Moran 1950) test of spatial autocorrelation indicates that the distribution of Clovis projectile points is indistinguishable from a random distribution (Moran's $I = -0.02$; $p = 0.90$), whereas the distribution of Folsom projectile points is clustered (Moran's $I = 0.11$; $p = 0.06$).

The densest concentrations of Clovis projectile points are associated with large, rare sites or site clusters such as Mockingbird Gap, Mineer, Blackwater Draw, and the San Pedro Valley. Although Clovis points are rare or lacking from certain areas (i.e., portions of the Sonoran Desert west of Phoenix, the southern border region between Arizona and New Mexico, and the Central and Southern High Plains of northeastern New Mexico), Clovis points occur in a variety of biotic settings, including rare sites in the western Sonoran Desert (Haynes 2011; Huckell 2004). In contrast, Folsom points are less widely distributed and more constricted in their distribution, with no occurrences in the northwestern Chihuahuan and Sonoran Deserts, in spite of intensive Paleoindian research in these areas (Huckell 1982; Gaines et al. 2009; Sánchez de Carpenter 2010).

LINKING HUMAN BEHAVIOR AND ENVIRONMENTAL CHANGE

Assuming that projectile point distributions provide a reasonably accurate reflection of human population distributions, their patterns across the landscape indicate



MAP 3.1. Distribution of Clovis and Folsom projectile points in Arizona and New Mexico.

broad changes in population distribution from Clovis to Folsom times. However, in order to understand the relationship between climate change and human land-use change, we need to understand not only Younger Dryas climatic conditions but also how behavioral responses to these conditions would be reflected in the archaeological record. Although no coherent model explaining the magnitude and direction of Younger Dryas climatic and environmental change exists for the Southwest (a problematic situation discussed by Ballenger, Holliday, et al. 2011), models have been proposed for the adjacent Southern High Plains (Holliday 1997, 2000) and the North American continent (Firestone et al. 2007; Haynes 1991). A review of these models and their archaeological predictions helps clarify the problems we face when attempting to identify the effects of Younger Dryas climate change on terminal Pleistocene populations of the Southwest.

Warmer/Drier to Cooler/Wetter or Vice Versa

Haynes (1991, 2008) has proposed a Clovis-age drought, with warm/dry Bølling-Allerød conditions that prefaced sudden Late Pleistocene extinctions at the beginning of a cooler/wetter Younger Dryas. In contrast, Holliday (2000) provides evidence from the Southern High Plains that, during the Folsom interval, climatic conditions were increasingly warm and arid compared to cooler/wetter Clovis period. Conflicting paleoenvironmental records of the Southwest provide some support for each model, but the models can be further tested by examining Clovis and Folsom projectile point distribution patterns in the Southwest. Assuming that early Paleoindian projectile points were hunting technologies employed in the pursuit of large grazers (mammoth and some bison by Clovis and bison by Folsom), then projectile point distributions should track suitable foraging conditions for grazers and the hunters who pursued them (Ballenger, Prasciunas, et al. 2011). If Clovis-age landscapes were characterized by falling water tables and circumscribed refugia where megafaunal grazers would be expected to cluster (Ballenger 2010a; Haynes 2002), as in the warmer/drier model, then it is reasonable to expect Clovis hunting weapons to be similarly clustered in their distribution, possibly around dwindling water sources (Haynes 2002, 1991; Haynes and Huckell 2007). In contrast, cooler/wetter conditions and rebounding water tables during the Younger Dryas would have enabled more widespread foraging for grazers and hunters, resulting in a more widespread distribution of Folsom points. The opposite would be expected if water tables fell during warmer/drier Folsom times (Holliday 2000).

The distribution of Clovis and Folsom projectile points in the Southwest (map 3.1) does not seem to fit the predictions of a Clovis drought followed by a cooler/wetter Younger Dryas. Clovis hunters appear to have foraged widely relative to Folsom hunters, and their tools do not cluster around paleo-lake bottoms, but

mid-elevation springs (Haynes 2008; Huckell 2004; Wessel et al. 1997). In contrast, Folsom points are constricted in space relative to Clovis and cluster around paleo-lakes and paleo-wetlands (Judge 1973; Hill and Holliday 2011). However, projectile point distribution patterns also do not entirely fit the predictions of a Folsom drought (warmer/drier Younger Dryas). Warmer/drier Younger Dryas climates would likely decrease available resources such as grassland forage, but Folsom populations in the Southwest and Plains appear to have increased relative to Clovis (Holliday 1997; Meltzer and Holliday 2010) (assuming, once again, that projectile point densities increase and decrease relative to population size). As an example, Amick and Lukowski (2006) report 227 Folsom points collected from the southern Tularosa Basin, indicating abundant bison and intensive hunting, compared to only 3 Clovis points. It is true that Folsom technologies lasted nearly twice as long as Clovis, but Holliday (1997) has shown that the number of Folsom sites is significantly more than twice that of Clovis. Others have explained prosperous bison herds and Folsom hunters using a cooler/wetter model of the Younger Dryas, pointing to increased grass production and competitive release following Pleistocene extinctions (Huckell and Judge 2006; Mullen 2008). However, as noted above, a cooler/wetter Younger Dryas model fails to explain the widespread distribution of Clovis points compared to the relatively clustered distribution of Folsom.

Extraterrestrial Impact

An alternative explanation for terminal Pleistocene population redistribution (and for Younger Dryas climate change itself), is the hypothesis that at around 12,900 cal BP, North America was subjected to some sort of extraterrestrial event (either an impact or impacts, airburst or airbursts, or some combination thereof) (e.g., Firestone et al. 2007; Kennett et al. 2009; Israde-Alcántara et al. 2012; Bunch et al. 2012). The hypothesized extraterrestrial event resulted in widespread devastation in the form of fireballs, intense winds, and extensive wildfires that decimated grassland and forest environments, destroying the food supply of large herbivores. Such an extraterrestrial impact would certainly be considered an “extreme event” (see Towner, this volume) and could have had numerous repercussions for human foragers across the continent. The extraterrestrial impact hypothesis includes suggestions of “major ecological reorganization,” “major catastrophic effects,” “dramatic ecological change” (Firestone et al. 2007:16,016, 16,017, 16,021), and “massive environmental changes” (Kennett et al. 2009:94), which led to abrupt Younger Dryas cooling, contributed to the late Pleistocene megafaunal extinction, and promoted human cultural changes. These events ultimately resulted in the termination of the Clovis culture.

Support for the extraterrestrial impact hypothesis comes from the presence of a suite of markers that reportedly occur in elevated concentrations in sediments

dating to approximately 12,900 cal BP found in sites widespread across North America (Firestone et al. 2007; Kennett et al. 2009). A series of publications, however, calls into question the validity of the geologic evidence for this impact (e.g., Boslough et al. 2013; Holliday et al. 2014; Pinter et al. 2011). In addition, a variety of independent studies have failed to replicate the results of the extraterrestrial impact proponents (e.g., Paquay et al. 2009; Surovell, Holliday, et al. 2009) or have shown that many if not most purported impact indicators are not unique to extraterrestrial processes (e.g., Scott et al. 2010; Wu et al. 2013) nor the onset of the Younger Dryas (Haynes et al. 2010; Pigati et al. 2012; Bement et al. 2014; Holliday et al. 2014), or they have falsified hypotheses raised by the impact proponents (e.g., Holliday and Meltzer 2010; Holliday et al. 2014; Meltzer et al. 2014). Further, an in-depth study of the 29 sites with claimed evidence for a Younger Dryas impact shows that at 26 sites the age control is very weak to nonexistent (Meltzer et al. 2014). The extraterrestrial impact hypothesis fails the critical chronological test of an isochronous event at the Younger Dryas boundary.

EVIDENCE FOR MAJOR ADAPTIVE SHIFTS

Leaving aside the issue of whether or not such an impact happened, this model argues that “major adaptive shifts” occurred among Paleoindian populations approximately 12,900 cal BP, largely in response to dramatic ecological change and the extinction of key prey species. Does the terminal Pleistocene archaeological record, either of the Southwest or the North American continent as a whole, support these predictions? While the extinction of thirty-five genera of mammals by the end of the Pleistocene was an ecologically significant event by any measure, Holliday and Meltzer (2010:576) have argued that there is no compelling evidence that extinction had a “fatal impact” on Clovis populations. This is because unambiguous evidence of predation can be demonstrated for few of the extinct genera (Grayson and Meltzer 2003, 2015; Surovell and Waguespack 2009; but see Surovell and Grund 2012), and Clovis foraging strategies are argued to have varied in prey choice and diet breadth rather than focused on large game, as traditionally argued (Cannon and Meltzer 2008). However, interpretations of Clovis subsistence strategies and Pleistocene extinctions are highly contentious. Others argue that Clovis hunters were indeed specialized big game hunters and that mass extinctions were both synchronous and catastrophic (e.g., Faith and Surovell 2009; Surovell and Waguespack 2009; Waguespack and Surovell 2003).

But in any case, the effect of large mammal extinctions is not readily apparent by obvious major adaptive shifts in the archaeological record. For example, although changes in material culture are evident between Clovis and post-Clovis times, these

changes are limited largely to projectile point design, with the rest of the toolkit remaining remarkably similar. While changes in weaponry design might reflect an adaptive technological response to changing environmental conditions or prey targets, they might just as easily have served a social function. After all, projectile point styles changed frequently and sometimes abruptly throughout prehistory, seemingly without the trigger of major climatic and environmental change. In addition, the fact that both Clovis and Folsom practiced arroyo-style bison kills, sometimes within the same arroyo (Bement and Carter 2010), suggests that changes in projectile point design were not entirely related to changing prey species (Holliday and Meltzer 2010).

EVIDENCE FOR DEMOGRAPHIC COLLAPSE AND CHANGING SETTLEMENT PATTERNS

Firestone and colleagues argued for demographic collapse based in part on the relatively larger number of Clovis points compared to post-Clovis forms in eastern North America (Firestone et al. 2007). The assumptions and potential problems implicit in this approach have already been discussed, and the problem is magnified in eastern North America, where enormous variation in fluted point types exists; temporal relationships among types is uncertain; and Clovis point counts are likely inflated while post-Clovis forms are undercounted (Holliday and Meltzer 2010). In any case, the archaeological record of the Southwest shows a marked increase in Folsom projectile points compared to Clovis, suggesting a post-Clovis population increase or range constriction rather than collapse (although this is not the case in portions of the northwestern Chihuahuan and Sonoran Deserts, where Folsom is thus far absent). Throughout the continent, a number of Clovis and Clovis-like fluted point sites also postdate the beginning of the Younger Dryas, indicating that Clovis technology did not end abruptly with the beginning of the Younger Dryas (Meltzer and Holliday 2010).

As further evidence for disruption in terminal Pleistocene settlement patterns and post-Clovis population decline resulting from extraterrestrial impact, Kennett and West (2008:E110) observe that sites containing both Clovis and immediately post-Clovis materials are rare and that when present, they are “nearly always” separated by sterile deposits (Kennett and West 2008:E110). However, Holliday and Meltzer (2010) note that the latter phenomenon is more easily explained by the geomorphic settings of the sites themselves than by any kind of post-Clovis population decline. In addition, *any* evidence of multiple successive Paleoindian occupations is rare. Examining the components represented by a sample of sites dating from Clovis through late Paleoindian times is instructive in this point: out of 156 sites, more than two-thirds (105) represent single components, the vast majority

of which are late Paleoindian (Holliday and Meltzer 2010). Specifically comparing the number of reoccupied Clovis sites with the number of reoccupied Folsom sites shows no statistical difference between them. Therefore, the apparent “disruption” in settlement patterns and landscape use evident at the beginning of the Younger Dryas is not unique. The fact that Paleoindians rarely used the same location on the landscape (with the exception of places that provided important but patchily distributed resources, such as high-quality raw material) may instead be a result of unrestrained mobility within the context of a relatively empty landscape (Holliday and Meltzer 2010). However, the lack of immediately overlying occupations at Clovis sites should also be expected based simply on the rarity of early Paleoindian sites with multiple components and, therefore, the extremely low likelihood of discovering such sites (Surovell, Finley, et al. 2009; Surovell 2010).

In sum, the archaeological record provides little support for the major adaptive shifts (as measured by changes in the Paleoindian toolkit), disruption in settlement patterns (as measured by a lack of site reoccupation), or demographic collapse predicted by the extraterrestrial impact hypothesis. Although large-scale changes in population distribution and land-use patterns are apparent in the Southwest from Clovis to Folsom times, these changes cannot be directly linked to Younger Dryas climate change itself, much less to an extraterrestrial impact that is argued to have triggered Younger Dryas climate change.

A SUMMARY OF THE PROBLEMS

The beginning of the Younger Dryas corresponds generally to several major cultural and ecological transitions apparent in the archaeological record. These include the transition from Clovis to Folsom; the extinction of the megafauna; an associated switch in large animal prey from mammoth and bison (Clovis) to primarily bison (Folsom); broad changes in land-use patterns, with increased Folsom regionalization; and Folsom population growth. Paleoenvironmental records and models explaining Younger Dryas climatic and environmental change in the Southwest, however, are conflicting and do not articulate well with the archaeological record. Clear links between Younger Dryas climatic change and changes in land-use patterns are therefore elusive. The major issues complicating our understanding of the effect of the Younger Dryas on terminal Pleistocene Paleoindian populations of the Southwest (and elsewhere) include

1. The rarity of terminal Pleistocene archaeological sites and high-resolution paleoenvironmental records that span the Bølling-Allerød/Younger Dryas boundary.

2. Inconsistencies in multi-proxy paleoenvironmental records, which prohibit a comprehensive understanding of the magnitude and direction of Younger Dryas climatic and environmental change (but which may, in fact, reflect the dynamic nature and variability in expression that characterized the Younger Dryas itself).
3. Issues of chronology, where the lack of well-dated paleoenvironmental records and archaeological sites inhibits correlation between environmental change and possible human response. In addition, the radiocarbon calibration curve is notoriously problematic during the Younger Dryas (Muscheler et al. 2008). Because of this, most sites that fall within the Younger Dryas cannot be dated more precisely than to a several-hundred-year span. Demonstrating that a particular cultural or demographic change evident in the archaeological record is a direct response to climatic or environmental change may therefore not be possible (Meltzer and Holliday 2010). This problem is compounded by an unknown lag time between climatic change, environmental change, and human response.
4. Problems of spatial scale, such as the use of site-specific, nonrepresentative paleoenvironmental records to reconstruct environmental change at a regional level across the entire Southwest and the use of county-level projectile point distributions to infer Paleoindian landscape use. County-level distributions act to mask point clustering by artificially spreading out what would be clusters across larger regions. This is a particular problem where county size is large, such as in Arizona and New Mexico, which makes Clovis points appear more widespread than they are (Ballenger, Prasciunas, and Holliday 2011).
5. Ambiguities in the terminal Pleistocene archaeological record, which complicate our interpretation of past human behavior. Although projectile point distribution patterns provide a large-scale perspective useful for identifying changes in prehistoric land-use strategies and (possibly) demography through time, various biases affecting point visibility may compromise some of the reality of the observed patterns. Even if these patterns provide completely true representations of past human behavior, interpreting the actual meaning of the apparent differences in land-use strategies between Clovis and Folsom populations is not a simple process. Comparisons between the expected adaptations of Clovis and Folsom populations to changing climatic and environmental conditions are complicated by the fact that Clovis groups were the first widespread inhabitants of an unoccupied continent. There is a theoretical reason to believe that Clovis populations would have used the landscape in unique ways compared to all other later populations, spreading far and wide while exploring an unknown world (Kelly and Todd 1988; Meltzer 2002). The more restricted land-use strategies of Folsom (and all

later) populations, then, must also be interpreted in this context and not assumed to directly mirror changing environmental conditions from Clovis to Folsom times. In addition, it is important to remember that projectile points represent a highly specialized set of behaviors and are capable of telling us only about a limited range of Paleoindian activities. The significance of this for affecting our understanding of Paleoindian land-use strategies will depend in part on whether terminal Pleistocene populations were big game hunting specialists or foraging generalists, a point that is still debated (e.g., Grayson and Meltzer 2015; Surovell and Grund 2012; Surovell and Waguespack 2008).

CONCLUSIONS

As this review of the terminal Pleistocene archaeological and environmental records of the Southwest indicates, there are a number of significant problems that we face when trying to understand the relationship between Younger Dryas climatic change and the changes evident in the archaeological record at this time. However, while ambiguities inherent in these records may prevent us from ever truly understanding the direct effects of Younger Dryas climatic change on prehistoric human behavior, this does not mean that the Younger Dryas did not affect terminal Pleistocene populations. We argue that the relative clustering of Folsom compared to Clovis and the apparent abandonment of large portions of the Chihuahuan and Sonoran Deserts during Folsom times indicate that large-scale changes in land-use patterns occurred during the Younger Dryas. The absence of Folsom points in these regions is a long-standing problem (Agenbroad 1967; Irwin-Williams and Haynes 1970; Faught and Freeman 1998; Sánchez de Carpenter 2010). It seems unlikely that research bias can explain a Folsom absence, considering the number of fluted point surveys that have been conducted (Agenbroad 1967; Haynes 2011; Huckell 1982) and the presence of Younger Dryas sediments in some local streams (Waters and Haynes 2001). Irwin-Williams and Haynes (1970) argued that the widespread distribution of Clovis materials across much of the Southwest indicates that environments capable of supporting key economic faunal species (specifically mammoth and bison) also existed over much of the Southwest during the Late Pleistocene and that the subsequent range “shrinkage” of Folsom was related to the geographical limits of bison during the Younger Dryas. Although the past forty-five years have altered the archaeological and paleoenvironmental details of the Younger Dryas in the Southwest, we suspect this model still holds explanatory power.

ACKNOWLEDGMENTS

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NOTE

1. The Younger Dryas Chronozone (Mangerud et al. 1974) refers to a temporal interval between 12,900 and 11,600 cal BP, when the proposed Younger Dryas global climate event is detected in Greenland ice core records. For simplicity, in this chapter we refer to both as the Younger Dryas.

Sunset Crater and Little Springs Volcano Eruptions

Disaster Management in the Eleventh-Century AD Southwest

MARK D. ELSON, MICHAEL H. ORT, AND KIRK C. ANDERSON

Volcano eruptions are some of the most powerful natural phenomena known to humans, with their influence on the cultural and natural environment extending far beyond the zone of physical destruction. As ethnographic and archaeological data attest, volcano eruptions can act upon cultural groups as catalysts, as processes, and sometimes as termination factors (see chapters in Cooper and Sheets 2012; Grattan and Torrence 2007; Sheets and Grayson 1979b). Likely accounts of eruptions are common in traditional histories, generally involving fires and molten rock from deep within the earth (Blong 1982; Sheets 2012). One of the earliest representations of a volcano eruption was painted more than 8,000 years ago on the wall of a shrine at Çatal Hüyük, Turkey, and memories of the Mount Mazama eruption in southern Oregon have been passed down through generations for almost 7,000 years (Krajick 2005; Sheets 2012; Sigurdsson 1999:figure 2.1). It is clear that humans have been reacting and adapting to volcanic eruptions for a very long time. These adaptations have sometimes been successful, but sometimes not.

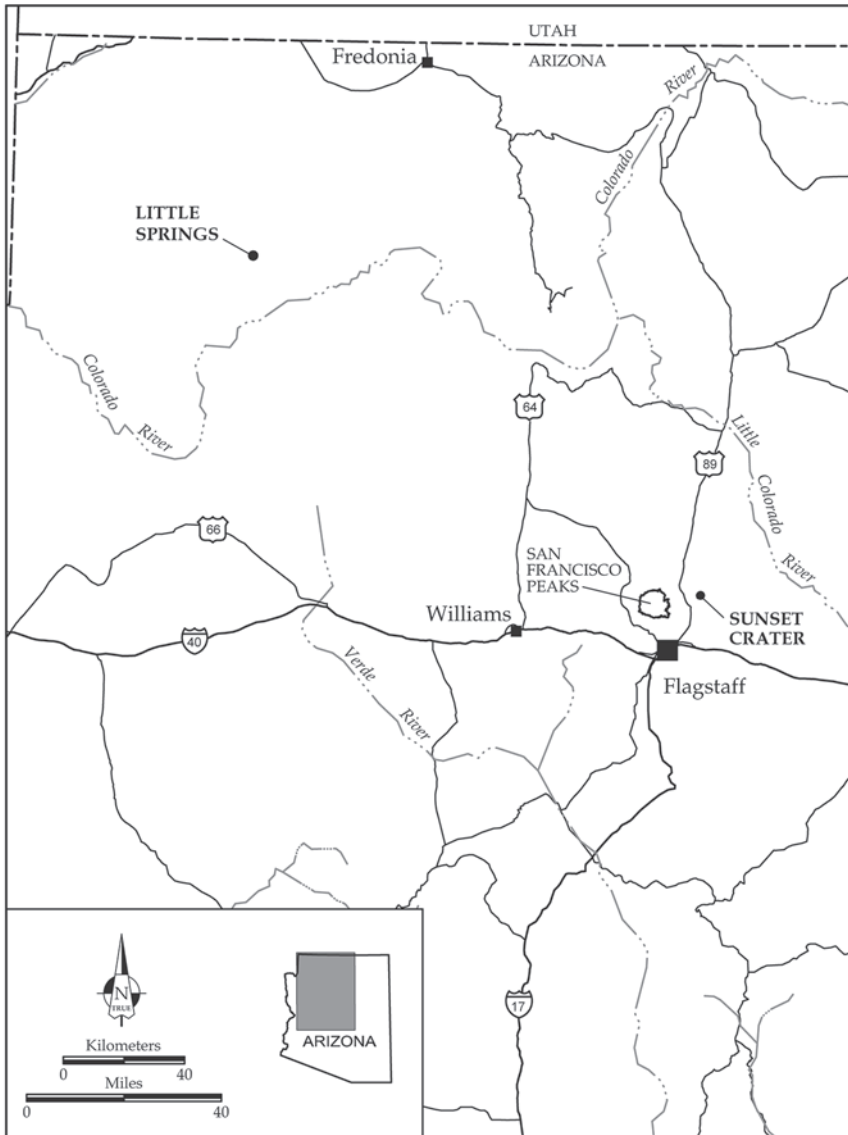
Volcano eruptions are “hazards,” but when combined with affected human populations, they rapidly become “disasters” that must be dealt with for survival. As the chapters in this section demonstrate, much of historical ecology deals with explaining human adaption to gradual processes, such as long-term changes in climate, demography, or plant and animal habitats—a field of study ideal for archaeological research (Dean and Doyel 2006:1–2). However, it is important to note that, in terms of human ecology and adaptation, volcano eruptions have both immediate and

long-term effects, a point emphasized by Ronald H. Towner in chapter 2, regarding the distinction between low- and high-frequency events. Although previous experience with a specific hazard type can result in a more effective response to both short- and long-term processes, the geographic and temporal spacing of volcano eruptions in the Southwest strongly suggests that prehistoric populations did not have active knowledge of these events or firsthand experience of how to deal with them (Ort, Elson, Anderson, Duffield, and Samples 2008). Eruption memories of these groups were as traditional histories, with the eruptions almost certainly assigned to supernatural or religious origins (Chester and Duncan 2007; Sigurdsson 1999).

Volcanic eruptions are highly idiosyncratic, dependent on an often unpredictable combination of cultural and natural variables. For example, outside of the direct immediate threat to life by lava flows, volcanic bombs, accompanying forest fires, and heavy tephra deposition causing structure collapse, volcano eruptions can also have effects that may take decades, or even centuries, to fully manifest, including acid rains, cooler temperatures, famine, vegetation destruction (and a reduced rate of regeneration), loss of animal habitat, and the removal of large portions of previously productive landscape from human use. To deal with these hazards requires multiple short-term responses and long-term strategies, the success of which is highly dependent on the ability to use cultural mechanisms to adapt to potentially harmful natural conditions.

In this chapter we discuss the eruptions and resulting human adaptations at two volcanoes, Sunset Crater and Little Springs, which occurred during the prehistoric occupation of northern Arizona (map 4.1). Both were basaltic volcanoes situated about 200 kilometers (km) apart that erupted within 100 years of each other, although they could have been contemporaneous or within a single human generation. Significantly, they caused different responses by affected local groups, even though these groups were similar in their social organizations, structures, and subsistence systems. Adaptive differences were largely due to contrasts in the nature of the two eruptions and the sizes of the devastated areas, although in both cases the response by local populations was highly successful.

We make use of all available data on the eruptions and affected areas in this discussion. However, significantly more data are available from Sunset Crater than from Little Springs (Ort, Elson, Anderson, Duffield, and Samples 2008; Ort, Elson, Anderson, Duffield, Hooten et al., 2008). Archaeological research in the Sunset Crater area over the past seventy years has resulted in the subsurface excavation of hundreds of sites containing thousands of structures (Colton 1946; Downum 1988; Elson 2006a, 2006b, 2011). Pedestrian survey data are also much more complete at Sunset Crater. In contrast, the understanding of the Little Springs area is almost entirely based on the results of an archaeological survey of 3,640 hectares



MAP 4.1. Sunset Crater and Little Springs Volcanoes in northern Arizona.

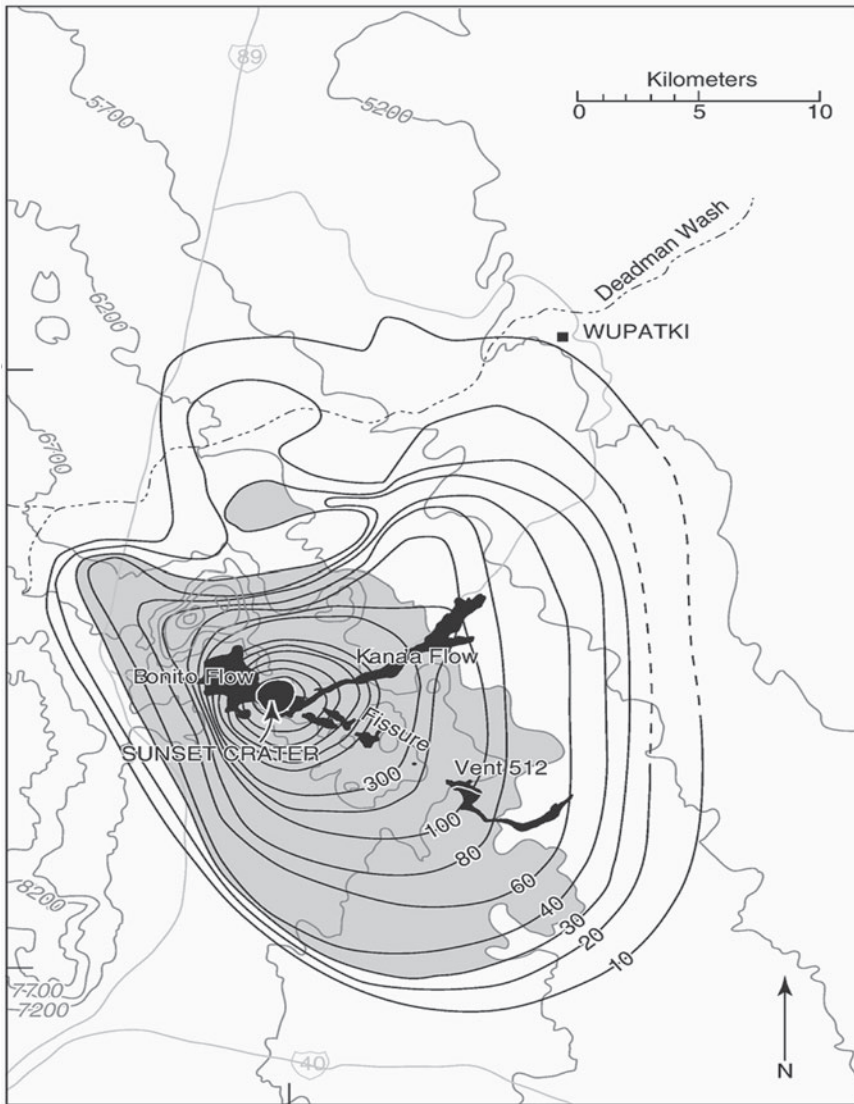
(ha) north of the Grand Canyon (Moffitt and Chang 1978) and our survey of a portion of the Little Springs lava flow (Elson and Ort 2006). No published subsurface excavations have taken place in this area.

Data for this study also rely on the historic period eruption of Parícutin Volcano, a cinder cone approximately 350 meters (m) high, which erupted in central Mexico between 1943 and 1952. Parícutin is the most well-studied cinder cone volcano in North America, and research has been undertaken on both geological and cultural processes related to the eruption, which displaced more than 5,000 Purépeche (Tarascan) subsistence farmers (Luhr and Simkin 1993; Nolan 1979, 1993; Rees 1979). Based on its size, tephra blanket, and other characteristics, Parícutin is considered by many to be a “twin” of Sunset Crater (Colton 1946; Ort, Elson, Anderson, Duffield, and Samples 2008; Ort, Elson, Anderson, Duffield, Hooten, et al. 2008; Pilles 1987) and is used in this study as a possible model for the prehistoric eruptions.

SUNSET CRATER VOLCANO

Sunset Crater is a cinder cone approximately 300 m high, located about 25 km north of Flagstaff, Arizona, in the San Francisco volcanic field, which covers an area of approximately 5,000 square kilometers (km²) along the southern margin of the Colorado Plateau (Tanaka et al. 1986). It is the youngest of approximately 600 cinder cones present in the volcanic field. Sunset Crater erupted into a volcanic landscape marked by abundant cinder cones with intervening flat areas underlain by older lava flows. Elevations in this area range between 1,800 and 2,200 meters above sea level (masl) and contain ponderosa pine (*Pinus ponderosa*) forest at elevations above approximately 2,040 masl, piñon-juniper (*Pinus edulis/Juniperus monosperma*) woodlands between approximately 1,890 and 2,040 masl, and desert grasslands below. Vegetation is directly correlated with precipitation and temperature: the low-elevation desert sage-grassland habitat receives less than 15 centimeters (cm) per year of rainfall but has a long frost-free growing season and hot summer temperatures; the pine-forested highland area receives over 50 cm of rainfall per year but has a very short and unpredictable growing season (Elson et al. 2006; Salzer and Dean 2007). Sunset Crater and its lava flows blocked the Kana’a Valley, a significant stream valley that drained part of San Francisco Mountain, a nearby large stratovolcano. Archaeological evidence suggests that this area was highly populated at the time of the Sunset Crater eruption (Downum and Gumerman 1998).

The eruption began with a fissure eruption phase, which formed a number of vents and possibly a “curtain of fire” that stretched from where Sunset Crater is now for about 10 km southeast to Vent 512 (map 4.2). Eventually, the eruption localized to a single vent to form the Sunset Crater cone that produced the main cinder tephra deposits covering around 2,300 km². During this phase, most of the two lava flows—the Kana’a and Bonito flows—were produced. These lava flows covered about 8 km² and issued from vents at the base of the Sunset cinder cone; the flows



MAP 4.2. Map of Sunset Crater area.

were covered by a thick cinder fall that continued to be ejected from the volcano during their emplacement. Both the Kana'a and Bonito lava flows have late-stage lobes without cinders blanketing their surfaces, indicating that the flows were active after the end of the cinder deposition and were roughly contemporaneous.

Geologically, the eruption appears to have been short in duration, an important factor in terms of human response. As discussed elsewhere, recent chemical analyses, paleomagnetic data, and archaeological evidence suggest that Sunset Crater likely erupted around AD 1085–1090, with the eruption lasting no more than a few months (Elson et al. 2002; Elson, Ort, Anderson, et al. 2011; Elson, Ort, Sheppard, et al. 2011). The short duration is supported by the lack of evidence for any significant hiatus within the cinder stratigraphic sequence. The cinder deposits are plane-parallel bedded, with no signs of wind or water action within the sequence. Today, the surface of the deposits is reworked every spring by strong winds, but the absence of reworking within the stratigraphic sequence implies that their deposition did not span a springtime. Based on lava discharge calculations, the Kana'a flow, which encompassed most of the duration of the eruption, was emplaced over a period of weeks to about three months (Ort, Elson, Anderson, Duffield, and Samples 2008).

Cinder cone volcanoes like Sunset Crater tend not to produce large explosions. Instead, they are formed by a single event that begins with an eruption from a small crack in the earth. They grow into cone-shaped features through lava fountaining—throwing lava spatter, cinders, and ash hundreds to thousands of meters into the air—with orange-to-red molten lava flowing from vents near the base of the cone. Cinder cone volcanoes can grow quickly. At Parícutin, the cinder cone grew to a height of 167 m in only six days (Rees 1979:251) and 336 m in a year, as if a mountain was seemingly produced out of thin air.

The Sunset Crater eruption was likely foreshadowed by ominous and portentous signs. Modern cinder cone volcanic evidence indicates these can include carbon dioxide “pockets,” which may kill animals, humans, and vegetation; the development of hot springs and gas fumaroles; ground swelling and fissures; strange animal behavior; subterranean explosions and other noises from deep within the earth; and earthquakes. Earthquakes are one of the most obvious precursors to an eruption and may occur several weeks or months prior to the event, increasing in frequency and magnitude over time.

At Parícutin, the first noticeable earthquake was more than six weeks before the eruption. Earthquakes began on a daily basis a week later; a month afterward, they occurred at the rate of 25–30 a day. On the day before the eruption there were around 300 measurable earth tremors (Luhr and Simkin 1993:3; Yokoyama and De la Cruz-Reyna 1990). These earthquakes were not minor events. The first Parícutin earthquake measured 4.4 on the Mercalli scale (Luhr and Simkin 1993:10). The Mercalli scale is a subjective measure of intensity based on observed effects and not directly comparable to the Richter scale, which is a measure of magnitude (Richter scale data are not available for the Parícutin eruption). An earthquake with a Mercalli intensity of 4.0 would have been “[f]elt indoors by

many, outdoors by few during the day. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sounds. Sensation like a heavy truck striking building. Standing motor cars rocked noticeably" (United States Geological Survey 1989:1).

During violent cinder cone eruptions, clouds of ash and steam may create their own weather system and thunderclaps and lightning around the volcano are common. At Parícutin, which was surrounded by several small villages of Purépeche farmers, there were no deaths from the lava or cinder fall itself, but associated lightning strikes killed three people and some livestock (Luhr and Simkin 1993:7; Nolan 1979:328). In addition, the heavy ash and cinder fall from Sunset Crater, along with the smoke from accompanying forest fires, must have darkened the daytime sky; at night, the volcano would have glowed a fiery red, easily visible from points several hundred kilometers distant. The roar of volcanic eruptions, which is sometimes accompanied by whistling, hissing, and knocking sounds from "the center of the earth," can be heard hundreds of kilometers away; it has been described as sounding like thunder, heavy surf, or artillery fire (Gadow 1930). To people who had never heard a sound louder than a clap of thunder, the prolonged roar of the eruption would almost certainly have been extremely impressive and very frightening.

Sunset Crater lava covered an area of about 8 km² to depths from 2 to 30 m. Given the high density of prehistoric settlement in areas just outside the flow, and the confinement of much of the flows to the typically farmed basins, numerous habitation and agricultural field sites were likely buried (Downum and Gumerman 1998:8; Elson, Ort, Sheppard, et al. 2011; Pilles 1978, 1979). The ash and lapilli fall covered 2,300 km² and was heaviest in areas closest to the volcano. Primary deposits as thick as 40 cm were found in the fill of a pithouse 5.5 km southwest of the volcano (Swartz and Elson 2006), and deposits more than 5 m in depth have been recorded near the cone (Amos 1986). Significant accumulations occurred at distances as great as 20–25 km away, such as at Wupatki National Monument to the north and in the Winona area to the south, where Sunset Crater cinder deposits between 5 and 10 cm have been recorded (Colton 1932b; Hooten et al. 2001:15).

The visibility of the eruption was calculated using digital elevational modeling, based on the estimated minimum and maximum heights of the ash plume (3–5 km), and lava fire fountain (260–660 m) (Elson, Ort, Anderson, et al. 2011:figure 8.3). The 3–5 km column height of the ash plume is based on the dispersion of tephra on the ground surface and compares well with that observed at Parícutin (4–6 km). These data indicate that the Sunset Crater ash plume could have been seen from distances as great as 400 km, including high points near Palm Springs, California; Las Vegas, Nevada; Durango, Colorado; west central New Mexico; and along the Arizona-Mexico border south of Tucson. Areas of significant prehistoric

population, such as Chaco Canyon, the Phoenix Basin, and the Four Corners area, were within, or very close to, areas in sight of the ash plume.

The fire fountain, which would have been particularly spectacular at night, was visible across a much smaller area but still could have been seen from points some 250 km away in southern Utah and in eastern, western, and central Arizona, including the top of the Bradshaw Mountains, about 75 km north of Phoenix. On cloudy nights, the fire fountain reflection would have been visible across a larger area. It is unknown how the eruption affected people living outside the immediate area, but most groups in the greater Southwest United States in the mid-AD 1080s would likely have been well aware that something very unusual was occurring in northern Arizona.

In many ways the tephra fall would have been more disruptive to local populations than the lava flows. Significantly, areas beneath cinder deposits greater than 15–20 cm cannot be farmed because the cinders do not supply sufficient nutrients for plant propagation (Rees 1979:258, 280–86; Segerstrom 1950; Sheets 1980:10; Sheets and Grayson 1979b:4; Waring 2007). Depending on the size of the eruption, deep cinder deposits can remove hundreds to thousands of square kilometers of land from cultivation. At Parícutin, cinder deposits greater than 15 cm covered 350 km², and deposits greater than 25 cm covered 185 km², causing the abandonment of large areas of previously fertile farmland (Rees 1979:272). Fortunately, the Parícutin eruption occurred two months following the harvest, so widespread famine was averted. Ash from Parícutin fell in Mexico City, some 320 km away, while in Uruapan, 25 km to the east, the heavy ash fall made car headlights and street lamps necessary during the day (Rees 1979:252). Data from the isopach mapping of Sunset Crater show an even larger area buried by deep cinder deposits, with around 590 km² under 15 cm of deposits and 450 km² under 25 cm of deposits, respectively (map 4.2).

A study of tephra depth and vegetation survival at Parícutin showed that almost all plants were killed in areas with greater than 1.5 m of deposited cinders and that most shrubs and herbs, as well as a significant number of large mature trees, were killed in areas with more than 50 cm of deposits (Rees 1979:270–75). At Sunset Crater, tephra deposits deeper than 50 cm covered almost 300 km². To the prehistoric inhabitants, this area would have been a black, barren wasteland, with dead trees littering the landscape. Areas with cinder deposits deeper than 15 cm were still largely barren thirty-five years after the Parícutin eruption, even though the region receives more than 150 cm of annual precipitation—three times the amount that falls in the Sunset Crater area. Vegetation recovery would have been even slower at Sunset Crater due to the more limited precipitation and shorter growing season, and it is likely that the almost 600 km² within the 15 cm isopach remained lifeless and barren for at least several generations (Elson et al. 2006:tables 2.1, 2.2).

The ash from volcanic eruptions can also cause significant respiratory problems, particularly for the very young and the elderly. Although no human deaths were recorded from respiratory issues at Parícutin, an estimated 4,500 cattle and 550 horses died from breathing the fine ash produced early in the eruptive period (Rees 1979:259). It is likely that the health of some individuals was adversely affected, perhaps for life. The arid, pine-forested environment surrounding Sunset Crater receives less than 50 cm of annual precipitation, and lava-ignited forest fires would have spread beyond the area impacted by the lava, displacing both human and animal populations while adding to respiratory problems. It is likely significant that Hopi accounts of the Sunset Crater eruption talk about huge conflagrations visible from the Hopi Mesas, some 100 km away (Ferguson and Loma'omvaya 2011; see also Malotki and Lomatuway'ma 1987).

Damage from cinder fall would also have occurred in areas many kilometers from the volcano. Data from modern eruptions indicate that 10–20 cm of ash, particularly when wet, is heavy enough to collapse modern roofs (Blong 1984), suggesting that prehistoric pithouse and pueblo structures at sites 15–20 km from Sunset Crater may have sustained significant damage. At Parícutin, local residents had to shovel cinders off their roofs every 2–3 days and cinder-caused roof collapse is now recognized as one of the most common causes of volcano-related death (Baxter 2000:1040).

The effects of the Sunset Crater eruption on the prehistoric inhabitants of the Flagstaff area must have been profound (Colton 1932a, 1932b, 1932c, 1937, 1946, 1960). At Parícutin, one of the major causes of volcano-related death was “loss of the will to live,” particularly among the elderly who had spent their entire lives in villages that now had to be abandoned (Nolan 1979). Ethnographic and archaeological data indicate that most groups residing near an active volcano incorporate this feature into their belief systems (Kirch 1985; Nolan 1979; Plunket and Uruñuela 1998a, 1998b; Scarth 1999). Eruptions are commonly seen as signs of spiritual transgressions, often being equated with punishment, and offerings are commonly made to rectify these “sins” and avert the ongoing destruction (Scarth 1999:2). The several distinct Hopi accounts of the Sunset Crater eruption, passed between generations as traditional clan history, present it as divine punishment for various offenses, including immoral behavior, gambling, and general corruption (Colton 1932a; Ferguson and Loma'omvaya 2011; Malotki and Lomatuway'ma 1987). Parícutin villagers blamed the eruption on the desecration of a religious shrine and “the wrath of God on a sinful people” (Nolan 1979:301) and erected a row of 2-m-high white wooden crosses in front of the moving flow to (unsuccessfully) prevent it from entering the village (Foshag and González-Reyna 1956; Luhr and Simkin 1993:figure 45).

A volcanic eruption is a full sensory assault; these features are seen, heard, felt, and smelled. The prehistoric world was a quiet place, with a short clap of thunder being the loudest sound regularly heard; the prolonged roar of an eruption would have been highly alarming, if not outright terrifying. For the prehistoric inhabitants of the Flagstaff area, the eruption of Sunset Crater Volcano was not only one of the most awe-inspiring sights that anyone had ever seen, but one almost certainly thought to have a supernatural origin.

Cinder cone eruptions tend to end abruptly, and when Sunset Crater stopped, the silence must have been remarkable. During the eruption, the cinders and much of the lava flows would have been cool enough to walk on (with sandals), and the hotter parts of the lava flows would likely have become walkable within months. The lava, fissures, and cinder cone would have continued to emit gases for many years, gradually declining in volume. Parícutin continues to put out steam 60 years after its eruption and Jorullo Volcano, which erupted in central Mexico around 240 years ago, still emits water vapor at temperatures close to 100°C (Michael Conway, pers. comm. 2003). On humid days, Sunset Crater and some of the lava flows would have been enveloped in steam, giving it a mystical appearance, which may have persisted for several hundred years. Plants would have gradually moved into the devastated zone over a period of decades to centuries, with the rate of recovery highly dependent on rainfall. It is significant to note that vegetation in the humid setting of Parícutin has recovered more completely in 60 years than Sunset Crater has after 925 years.

LITTLE SPRINGS VOLCANO

Little Springs Volcano is located in the Uinkaret volcanic field, north of the Grand Canyon in the Arizona Strip area of northern Arizona (map 4.1). It is the youngest vent of 200 vents in the volcanic field (Billingsley et al. 2001). Before the eruption the Little Springs area was a valley between volcanic highlands, with a north-to-south elevation gradient from about 2,000 masl to 1,850 masl and valley sides that reached 2,200–2,300 masl. Like Sunset Crater, vegetation varies by elevation (Ort, Elson, Anderson, Duffield, and Samples 2008). Precipitation averages around 30 cm per year, with the growing season generally long enough for successful corn agriculture. Surface water in the Little Springs area is limited and occurs today only as small springs near the northern and southwestern termini of lava flows. Surface water sources at the time of the eruption are unknown.

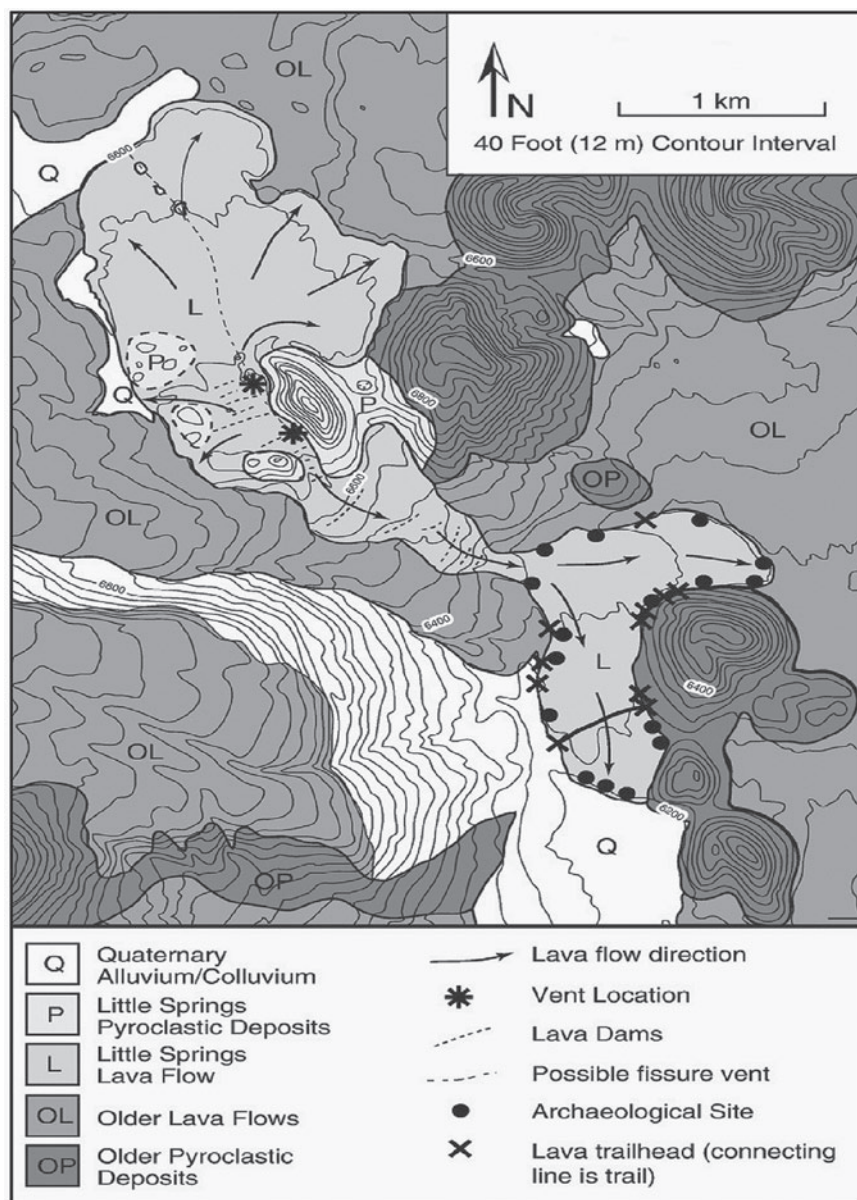
The Little Springs was a low level, or Hawaiian type, eruption, producing spatter ramparts and lava flows but no sizeable cinder deposits. The eruption was also significantly smaller than Sunset Crater, which, when combined with the nature of the eruption, resulted in different impacts that required responses by the

local population. The tallest volcanic landform at Little Springs is a 100-m-high, 400-m-long spatter rampart, with a vent complex on its west side that fed a northern and a southern lava lobe (map 4.3).

The eruption likely began from a short-lived, 2-km-long north-northwest-trending fissure that extended from the current area of the main spatter rampart. Two primary vents are present. Most or all of a northern vent fed the northern flow lobe, which spread over a valley 1 km wide and formed a broad, blocky lava field. A southern vent fed the southern flow lobe, which flowed down the steep slope toward a lower open valley about 1 km away. Once the flow reached flat land, it spread out, partially surrounding a preexisting cinder cone. The eruption covered an area of about 5 km² with lava flows and spatter deposits. Another 1 km² of land east of the main spatter rampart was heavily impacted by deposition of lava bombs and blocks. Outside of this 6 km² area, however, the eruption likely had few permanent effects. Fires and acid rain may have hindered vegetation for a short period, but the forest in this area evolved in a fire regime and, without a thick cinder blanket, likely recovered quickly.

The absence of stratigraphically distinct lobes indicates that the Little Springs eruption probably lasted for a period of weeks to, at most, a year; discharge calculations based on the volume of extruded lava also suggest a short eruption with a maximum extent of a year. Cosmogenic helium was initially used to date the eruption, producing a date of 1300 ± 500 cal BP, placing it within the period of prehistoric occupation (Fenton et al. 2001). The most accurate dating, however, comes from sherds encased within lava spatter blocks (figure 4.1a), similar to the maize-impressed spatter blocks, or “corn-rocks,” found at Sunset Crater (figure 4.1b) and discussed below. A number of the sherds are the type Hurricane Black-on-gray, a Black Mesa Black-on-white analog that conservatively dates between AD 1025 and 1200. Based on the site architecture, a tighter range for the occupation between AD 1075 and 1125/1150 can be suggested (Altschul and Fairley 1989; Elson and Ort 2006).

The Little Springs eruption significantly altered the landscape by the addition of lava flows, spatter ramparts, and a bomb field to the east of the main spatter rampart. However, the terrain outside this area, including surface stream drainages, was largely unaltered. Like Sunset Crater, much of the lava flow surface is devoid of vegetation today, but because there was little or no cinder and ash deposition, agriculture and habitation were possible right up to the edge of the flow. Only the 6 km² area directly beneath the Little Springs spatter rampart, lava flow, and lava bomb areas were heavily impacted (Elson and Ort 2006). Therefore, unlike Sunset Crater, where an almost 300 km² area had to be abandoned, occupation at Little Springs continued largely unaltered, with only minor population displacement. The eruption itself would still have been spectacular and almost certainly



MAP 4.3. Little Springs Volcano and surrounding area.

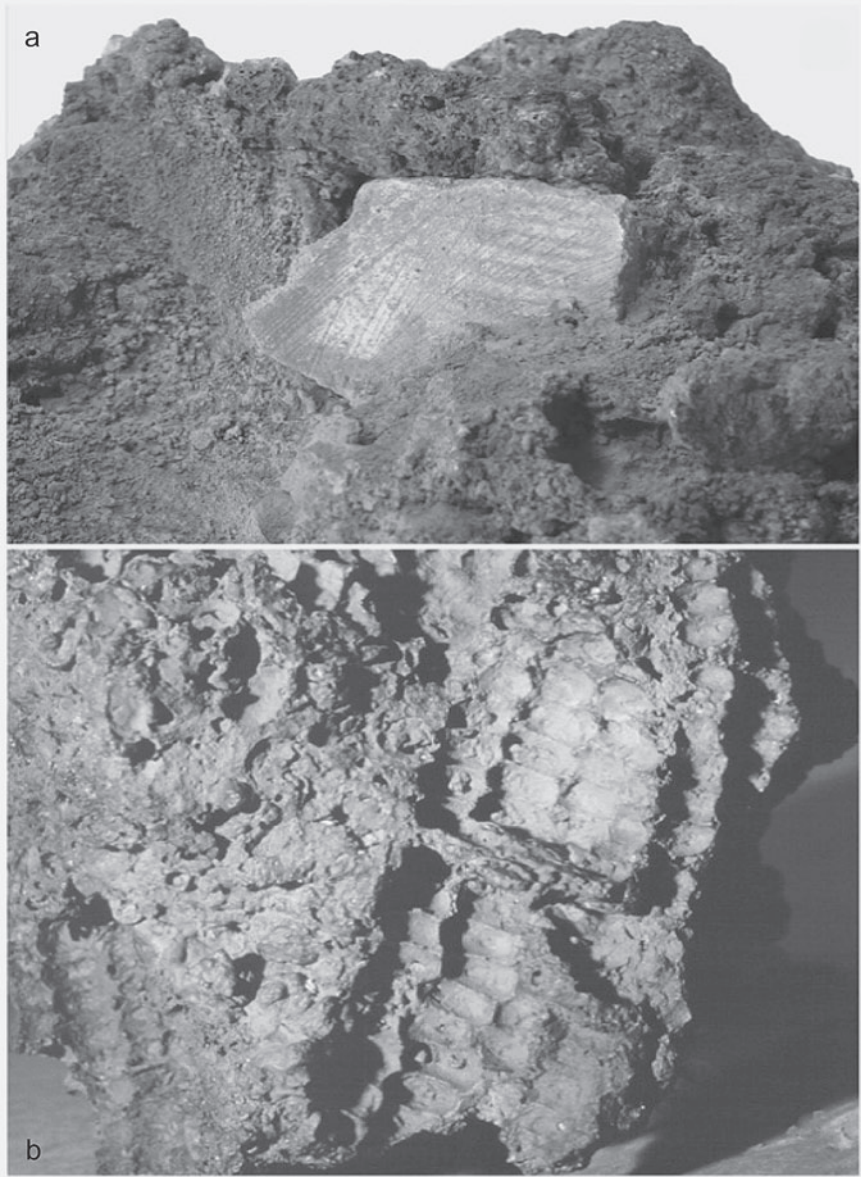


FIGURE 4.1. Photographs of (a) “sherd rock,” Little Springs lava flow, and (b) “corn rock,” Sunset Crater lava flow.

awe-inspiring, with the explosive ejection of lava bombs and red-glowing lava flowing from the two vents. However, settlement in areas outside of the flow itself was probably not disrupted, or if so, only for a short period. Significantly, the lack of a cinder eruption column means that the eruption itself was probably only visible on a local level. Unlike Sunset Crater, the regional impact of the Little Springs eruption cannot be estimated.

DISCUSSION

The eruption of Sunset Crater Volcano dramatically and permanently altered the physical and cultural landscapes of northern Arizona. The smaller Little Springs eruption also permanently affected these landscapes but less dramatically. The viewshed analysis strongly suggests that Sunset Crater was directly visible throughout the greater prehistoric Southwest (Elson, Ort, Anderson, et al. 2011:figure 8.3). The Little Springs eruption was likely known as well, but probably through word of mouth rather than direct visual experience. Human deaths are rare in small cinder cone eruptions like Sunset Crater and Little Springs. The more typical impacts associated with cinder cone volcano eruptions and small-scale disasters in general involve population movement or migration; resource scarcity; increased cooperation or increased competition, particularly for food resources; and psychological or emotional displacement. The scale of these impacts is dependent on a number of variables, including the severity, proximity, and type of the eruption and the nature or cultural practices of the affected group (Cooper and Sheets 2012; Grattan and Torrence 2007; Nolan 1979; Reyecraft and Bawden 2000a; Sheets 2012; Sheets and Grayson 1979a). Ethnographic and archaeological data indicate that agriculturally productive land, crops in the fields, habitation structures, and storage features are particularly vulnerable to eruption-related damage (Blong 1982; Luhr and Simkin 1993; Nolan 1993).

Because northern Arizona is a marginal environment for agriculture, the potential destruction of crops and even some stored resources could have been major disasters, resulting in migration, famine, and starvation. Eruptions are also well documented to change the location, flow, and number of water sources. Consequently, understanding the changes in both the natural and human realms due to the eruptions has important implications for reconstructing the prehistoric settlement of this part of the greater Southwest.

Similarities in settlement, subsistence, and social organizations of the preeruptive groups living in the Sunset Crater and Little Springs areas allowed for successful adjustments to the eruptions, but these adjustments were distinct. Habitation sites and agricultural fields were destroyed in both areas, but after a short period, the

affected populations thrived. However, after the initial response—which involved migration out of the areas beneath lava and heavy cinder cover, with likely reliance on kin and other established social networks for shelter and subsistence—the two groups differed in their long-term adaptations. While social differences between groups may have contributed to the use of distinctive adaptive strategies, differences in the nature of the two eruptions were likely the primary causal factor.

Although Sunset Crater was a larger eruption, affecting a larger population than Little Springs, the prehistoric peoples who lived and farmed in these areas were similar: both areas were occupied by small groups of subsistence farmers living largely on maize agriculture, along with the cultivation of beans, squash, and cotton. Animal protein consisted largely of small game (e.g., rabbits), with the occasional large mammal such as deer; the gathering of wild foodstuffs (e.g., amaranth seeds, pine nuts, cactus fruit) was also an important dietary supplement. Agricultural fields were small, generally encompassing no more than 10–20 ha, with most around 1–5 ha. Irrigation was, for the most part, not possible due to the lack of large streams with dependable water flow. Instead, water control features, such as linear rock terraces or rock and brush check dams placed across small drainages, were used to slow water and entrap soil. The small size of the fields was partly due to environmental parameters. Because Sunset Crater and Little Springs were at the fringes of the viable maize agriculture zone, farmers practiced a risk minimization strategy, with small agricultural plots placed in a number of different microenvironments varying in elevation, slope, exposure, substrate, soil type, and water source. This strategy ensured that some crops would be harvested in all but the very worst years.

Prior to the eruptions, most habitation sites were small, sufficient for one or two likely kin-related families living in semisubterranean pit structures and surface masonry rooms built from local materials (Bradley 1994; Downum 1988; Elson 2006a, 2006b; Pilles 1978). A few larger sites were also present, containing 10–20 structures, which were probably inhabited by several unrelated families. Although there are no visible wealth or status differences between larger and smaller sites, the larger sites may have served an integrative function for a number of smaller villages.

The prehistoric inhabitants of the Sunset Crater and Little Springs areas were in many ways preadapted to successfully manage the eruptions and, by extension, small-scale disasters in general. Village group sizes were small, with one or two independent families. As suggested by archaeological data, the social structure was nonhierarchical, with decision-making at the household or extended family level (Kamp and Whittaker 1999). The larger group size at even the few larger sites with more structured or hierarchical social organization would still have facilitated rapid decision-making. Larger multisite social groups (or communities) were likely linked together for religious purposes, marriage networks, or defense. In the post-eruptive

period, however, and particularly in the Sunset Crater area, groups aggregated into large, multifamily pueblos with more complex social structures.

ADAPTATION TO THE SUNSET CRATER ERUPTION

The Sunset Crater eruption was by far the more significant of the two. Archaeological data indicate four primary responses made by Sunset Crater inhabitants to this extreme event: (1) short to moderate distance (5–35 km) migration, particularly as compared to the long-distance migration discussed in Deborah L. Huntley's introduction to chapter 12 (this volume); (2) use of new agricultural methods; (3) changes in ceramic production and exchange networks; and (4) initiation of volcano-related ritual behavior.

In the early 1930s, Harold S. Colton (1932c:16) hypothesized that a thin layer of Sunset Crater cinders served as a water-retaining mulch, allowing lower elevation areas that were previously too dry to farm—such as Wupatki National Monument, an area that contains hundreds of prehistoric rooms—to become agriculturally productive (Colton 1946, 1960; see Anderson 2011). Experiments by Stuart H. Maule (1963), Colton (1963b), and Gwendolyn Waring (2007) strongly support the necessity of cinder mulch for agriculture at lower elevations. At an experimental agricultural plot near Wupatki, at approximately 1,735 masl, Waring (2007) found that no maize germinated without a cinder mulch cover. The experimental data are supported by modern accounts, where abundant harvests following an eruption are commonly reported in areas with a thin cinder layer (Blong 1982; Luhr and Simkin 1993; Sheets and Grayson 1979b). These data suggest that a thin cinder cover of around 3–10 cm is beneficial to crop growth. Conversely, both the experimental and modern data indicate that a cinder cover greater than 15 cm is detrimental to agriculture and that maize will not grow in cinders deeper than 20–25 cm. Cinders continued to affect agriculture thirty-five years after the Parícutin eruption, where vegetation in areas with more than 15 cm of cinders had still not recovered (Rees 1979). At Sunset Crater we use the 30 cm cinder isopach, which encloses about 400 km² (map 4.2), to conservatively estimate the area that was no longer farmable. The heavy tephra fall within this area must have also caused severe damage to agricultural crops, as well as significant structural damage, with many houses sustaining roof and wall collapse.

Archaeologists have long known that the higher elevations in the Flagstaff area were occupied earlier, which was likely related to the availability of sufficient rainfall for agriculture (Colton 1946; Pilles 1979). The average elevation of sites prior to the Sunset Crater eruption was over 2,000 masl (Elson, Ort, Anderson, et al. 2011:figure 8.7). Due to precipitation limits, 1,890 masl was the lower limit for most

pre-eruptive settlement in the Sunset Crater area because maize could not reliably be grown below that altitude. Of the 400 km² of land covered by more than 30 cm of tephra, about 265 km² was above 1,890 m in elevation and received enough rainfall for maize growth, making it prime agricultural land that had to be abandoned following the eruption (Elson, Ort, Anderson, et al. 2011; Elson, Ort, Sheppard, et al. 2011; see gray-shaded area in map 4.2). Conversely, areas below 1,890 masl with cinder deposits between 3 and 10 cm would now have become suitable for farming due to the water-retaining properties of cinder mulch combined with the long growing season.

At an elevation of 1,580 masl, the Wupatki area averages only around 18 cm of precipitation per year, although the length of the growing season is more than sufficient for agriculture (Elson et al. 2006:table 2.1). Non-mulched corn needs at least 25 cm of annual precipitation, 10 cm of which must fall during the growing season (Muenchrath and Salvador 1995). Therefore, prior to the eruption of Sunset Crater and the deposition of cinder mulch, the Wupatki area did not regularly receive enough rainfall to support the cultivation of corn. The experimental work, however, shows that with cinder mulch, 18 cm of annual precipitation is sufficient for corn germination (Maule 1963; Waring 2007). The beneficial effect of the cinder mulch is also strongly supported by the results of the Wupatki National Monument inventory survey, where of the 977 sites that could be dated, only 2 (0.2 percent) were definitively occupied prior to the eruption, indicating a large migration into the lower elevations after this time (Downum and Sullivan 1990).

The settlement of the Wupatki area, and the lower elevations in general, was also likely related to a moister climatic regime between AD 1050 and 1090 (Ort, Elson, Anderson, Duffield, and Samples 2008; Salzer and Dean 2007; Salzer and Kipfmüller 2005). During this forty-year period nearly 80 percent of years had average or above average precipitation, with over 60 percent being above average. In this arid and often unpredictable region, the occurrence of above average precipitation more than 60 percent of the time represents particularly favorable conditions for rainfall-dependent farming. Without the cinder mulch, however, the increased precipitation would not have been sufficient to support the large permanent populations that settled the Wupatki area. For settlement to occur, prehistoric groups that migrated into the newly fertile lowlands would have needed a new agricultural technology based on “cinder management”—the continual monitoring and management of cinder depth to ensure that a 3–10-cm-deep layer of cinders remained over agricultural areas.

Given the seasonally strong winds in the Flagstaff area, cinder management required a number of behavioral adjustments. Average agricultural plots in Wupatki National Monument are very small, about 0.4 ha (Travis 1990), making it easier to

maintain a consistent layer of cinders across the cultivated area. As discussed by others, the plots commonly contain linear rock alignments and rock borders, at least some of which probably functioned as soil or water traps or to protect young plants from the wind (Downum and Sullivan 1990; Travis 1990). Because many of the alignments are oriented perpendicular to the dominant wind direction, rather than to the land's slope, they were also likely used to trap and manage cinders (see also Colton 1960).

Demographic estimates suggest that the eruption of Sunset Crater caused 1,000–2,000 people to abandon their villages and agricultural land and become volcano refugees (Elson, Ort, Anderson, et al. 2011:table 8.2). This estimate is based on the area within the 30 cm cinder isopach; the actual figure was likely higher. However, displacing even 1,000–2,000 people is a large number in an area that is already agriculturally marginal. While the volcano refugees probably moved in with neighbors and nearby kin in less affected areas for a few years, the number of displaced people is too large to be easily incorporated into existing settlement and subsistence systems. It became necessary for the refugees to find uninhabited arable land elsewhere.

The Wupatki and Winona areas are north and south of Sunset Crater and were likely volcano refugee destination points. Previous researchers have suggested that the Wupatki area was settled by migrants from Pueblo areas to the east and west who were not affected by the eruption but who moved there to take advantage of the cinder mulch and the newly fertile land (Anderson 1990; Colton 1946; Downum and Sullivan 1990; Sullivan and Downum 1991). However, the most parsimonious explanation for the increase in population at lower elevation is that volcano refugees who had been displaced by the Sunset Crater eruption occupied many, if not most, of the sites (Elson et al. 2007; Ort, Elson, Anderson, Duffield, and Samples 2008). This inference is supported by the new dating of the eruption to sometime in the period between AD 1085 and 1090 (Elson, Ort, Sheppard, et al. 2011) instead of the long-entrenched date of AD 1064 (Smiley 1958; see Downum 1988). In this scenario the estimated 1,000–2,000 people displaced by the heavy cinder fall and lava flows would have first moved in with kin in unaffected areas, but shortly after, they began to settle regions with less than 10 cm of cinders. Tree-ring dates at sites within the 10 cm cinder isopach further support this possibility: the pithouse site of Heiser Springs, situated 50 m east of Wupatki Pueblo, was probably the initial Wupatki Pueblo settlement, with tree-ring cutting dates between AD 1094 and 1096 (Robinson et al. 1975:48); the site of Winona, a large pithouse village around 20 km south of Sunset Crater, has tree-ring cutting dates between AD 1085 and 1087 (Robinson et al. 1975:90). Although all prehistoric demographic exercises are potentially problematic (see Kulisheck, this volume), our inference underscores the impact of the eruption on the local settlement and the subsequent migration

that occurred. The population displaced by heavy Sunset Crater cinder fall must be taken into account in all archaeological explanations, a factor not included in previous reconstructions.

Ceramic technology and exchange also changed following the eruption. The great majority of undecorated, utilitarian ceramics used in the Sunset Crater/Wupatki area prior to the eruption were Alameda Brown Ware (Colton 1946, 1958; Downum 1988; Van Keuren et al. 2007). Petrographic analysis of ceramic temper indicates most of these ceramics derived from a relatively small area just south and west of Sunset Crater (Heidke et al. 2007). Following the eruption, about 50 percent of this petrofacies (temper source area) for Alameda Brown was covered with 20–40 cm of tephra, likely causing disruption and perhaps abandonment of the temper source and the pottery manufacturing sites within it.

The petrographic data further confirm that following the eruption, another ceramic, San Francisco Mountain Gray Ware, was probably made in unaffected areas 50–60 km west of Sunset Crater and largely replaced the brown ware (Heidke et al. 2007; Van Keuren et al. 2007). The exact source area has not been located, but it is clear that the gray ware, which does not have volcanic temper, was made outside of the region affected by the Sunset Crater eruption and outside of the larger San Francisco volcanic field (Carter and Sullivan 2004; Carter et al. 2011; Heidke et al. 2007; Roberts 2001). In this respect, San Francisco Mountain Gray Ware producers may have increased ceramic production to fill the gap left by the disruption in Alameda Brown Ware production. Accordingly, the frequency of San Francisco Mountain Gray Ware recovered from sites located in the Sunset Crater area increased almost immediately after the eruption. Moving ceramic vessels 50–60 km may seem unreasonable; but several major drainages in the area would have provided natural pathways, and this distance for ceramic movement is supported ethnographically (Beier 1980; Crossland and Posnansky 1978; Heidke et al. 2007; Malville 2001). It is possible that these outside producers increased ceramic production to fill the gap left by the termination in locally produced ceramics. What was exchanged for these ceramics is unknown, although it may have involved foodstuffs, cotton, and other goods from the newly settled areas.

Finally, the Sunset Crater eruption may have led to the initiation of volcano-related ritual behavior. The recovery of over 50 pieces of Sunset Crater basalt with prehistoric maize cob and stalk impressions, termed *corn rocks* (figure 4.1b;), from the surface of a site 4 km from the nearest lava flow (Elson et al. 2002) supports this suggestion. Another 950 pieces of Sunset Crater basalt without corn impressions were also recovered from the site, and these likely represent pieces of lava that were brought to the site and then cracked open to expose the corn casts. We have argued elsewhere (Elson et al. 2002) that the characteristics of the corn rocks, along with

experimental data, suggest that the rocks were made deliberately through placement of maize cobs as an offering around an hornito (small rootless spatter cone). Because maize is a sacred plant to all Pueblo groups, it is likely that it served a similar purpose prehistorically. Why over 40 kilograms of rocks with maize casts were transported to a habitation site 4 km from the lava flow is unknown, but the effort required in collecting, carrying, and then exposing the corn remains in these pieces argues against the casual transport of a volcano souvenir. We suggest that the corn rocks themselves may have become a source of power or, given that one was found embedded in the wall of a structure, used as protection from the malevolent forces of the volcano. Both prehistoric and modern offerings are commonly associated with volcanoes in other parts of the world (Luhr and Simkin 1993; Plunket and Uruñuela 1998a, 1998b; Scarth 1999; Sigurdsson 1999) and should be expected in the Sunset Crater area. Our evidence is the first from the Southwest of possible ritual behavior related to volcanism.

ADAPTATION TO THE LITTLE SPRINGS ERUPTION

The Little Springs eruption had little cinder deposition, and only a 6 km² area directly beneath the spatter rampart, lava flow, and lava bomb areas had to be abandoned (Elson and Ort 2006). The much smaller size of the eruption meant that the adjustments by Little Springs groups was distinct from that at Sunset Crater and largely immediate in nature, with three primary responses: (1) very short-distance (1–5 km) migration; (2) occupation of the lava flow top; and (3) possible initiation of volcano-related ritual behavior.

As mentioned earlier, archaeological research in the Little Springs area is limited, but a pedestrian survey by Kathleen Moffitt and Claudia Chang suggests a high site density, similar to that around Sunset Crater (Moffitt and Chang 1978). Extrapolating from these data, 45 habitation sites may have been buried by the eruption, encompassing at most a few hundred people. This is significantly less than the 1,000–2,000 people conservatively estimated to have been severely impacted by the Sunset Crater eruption.

Unlike Sunset Crater, the absence of cinders at Little Springs meant that occupation could continue on and near arable land right up to the flow edge of the eruption. Lava block masonry structures were constructed abutting the lava face at the base of the flow, with more structures constructed on top of the flow itself. A reconnaissance archaeological survey of just a portion of the southern lava lobe recorded 16 sites (map 4.3) containing a total of around 50 structures at the base and 150 structures on the flow top (Elson and Ort 2006). Large sites contained structures on both the flow top and at the base. As one example, the largest recorded site has

more than 45 structures on top of the lava and another 10 structures at the base. Most of the flow-top structures were 1–2-m-deep pits or dugouts excavated into the lava flow that were enclosed by low lava block walls. Due to the nature of the lava, many of these had rough and irregular bottoms and would not have been comfortable places to live for very long. Only a few sherds and flaked stone artifacts were associated with flow-top structures. Structures at the base of the flow had more typical coursed lava block masonry rooms with associated low- to moderate-density artifact scatters. The lack of artifacts and the expedient nature of structure construction suggest that the flow-top rooms were not designed for long-term habitation but may have been defensive. However, use of some of these structures for other functions, such as ritual, cannot be ruled out. This suggestion is supported by ethnographic research among the Southern Paiute and other Numic-speaking tribes of the Great Basin. These groups view the Little Springs lava flow, and most volcanic features in general, as a source of *Puha*, which is the “force that was placed in all things at the time when the world was created . . . [It is] the spark that keeps the world going” (Stoffle et al. 2004; 2009:2).

A defensive function for the majority of structures on the top of the lava flow is also supported by an intricate and extensive network of trails that trend both north-south and east-west across the rough and blocky lava, an area that without trails would have been extremely difficult and dangerous to transverse (map 4.3). The trails were constructed by using small lava blocks to fill in holes and smooth the rough surfaces, a task requiring significant engineering and labor. Based on their number and manner of construction, it is likely that more energy was put into trail construction than into the flow-top masonry structures. Scattered along the trails are a few rock cairns and isolated ceramic sherds, likely marking trail routes or intersections. The building of these trails suggests a concern with rapid movement, a necessity in defensive situations. The somewhat excessive energy invested in trail construction could also be related to their role in ritual practices, but this suggestion seems less likely. Because the trails all have rough and somewhat hidden access and because the trailheads cannot be seen from the base of the flow, someone familiar with the lava flow and the trails and fortifications would have had a significant advantage over any invader. That lava flows can serve as excellent defensive retreats is amply demonstrated by the Modoc War of the early 1870s, where the US Army estimated that they would need at least 1,000 troops to defeat the 100–200 Modoc hiding in lava beds along the shores of Tule Lake in Northern California (Beck and Hasse 2004). The need for defensive fortifications in the Little Springs area is unknown, but it is at least a strong possibility for the presence of the flow-top structures and trail systems.

Prehistoric ceramic sherds embedded in Little Springs lava spatter agglutinate (figure 4.1a) were recovered from a small masonry pueblo situated about 0.7 km east

of the northern lava flow (Elson and Ort 2006). The 11 recovered lava-embedded sherds represent at least two different ceramic types, and most were found clustered on the site surface within a single room. Given the size of the lava blocks and the nature of the room walls, the lava-embedded sherds probably represent pieces of collapsed wall fall. We have argued elsewhere (Ort, Elson, Anderson, Duffield, and Samples 2008) that the sherd-embedded rocks were made in a similar way to the corn rocks at Sunset Crater. In this case, instead of maize, sherds (or possibly whole vessels) were placed on the rampart of an hornito and covered with highly fluid lava spatter. Blocks of sherd-embedded lava were later retrieved during a quiescent period and carried to the habitation site, where they appear to have been placed in the walls of a single room. Although the meaning behind this behavior is unknown, like the corn rocks, the effort required to make and transport the sherd-embedded lava implies that it was more than just a curiosity or volcano souvenir. It is conceivable that the sherd rocks may have had religious meaning.

Therefore, following the Little Springs eruption and the probable abandonment of the immediate area for a brief period, the most likely scenario is that the lava flows were used for defensive purposes as a type of hidden, fortified retreat, while habitation and farming occurred right up to the flow edges. Like volcanic features all over the world, the lava flow most likely had ritual power, and some of the flow-top structures may have been used for this as well. Interestingly, Little Springs continued to be used as a defensive hideout into the nineteenth century when, in 1857, fugitives from the Mountain Meadows Massacre in southern Utah retreated into the lava flow (Hunt 1978).

CONCLUSION

Sunset Crater and Little Springs volcanoes are situated less than 200 km apart and erupted in similar environments at around the same time and among groups practicing a similar lifestyle. However, the short- and long-term effects of the volcanoes on local populations were markedly different, due largely to differences in the nature of the eruptions. Whereas Sunset Crater caused the migration of a minimum of 1,000–2,000 people, development of new agrarian techniques, and alterations in ceramic production and exchange systems, Little Springs had little effect on population distribution and subsistence systems, outside of the displacement of at most a few hundred people by the lava flow itself. The lack of a significant cinder blanket at Little Springs accounts for much of this difference, so that only settlements within the 6 km² area covered by the spatter rampart and lava flow had to be abandoned compared to the 400 km² (or 265 km² with high-density settlement) area that had to be evacuated in the Sunset Crater eruption.

The Sunset Crater lava flows were not reoccupied and only sporadically used, almost certainly because local populations moved tens of kilometers away due to the heavy cinder fall around the flow areas. This distance would also have potentially placed the volcano refugees into the territory of other groups. Only a small portion of the area covered by Sunset Crater lava has been archaeologically investigated, but artifacts discovered during preliminary surveys suggest that local prehistoric groups made very limited use of the lava-covered areas, including stashing ceramic jars for water collection and to serve as food and water caches for travelers and the placement of prayer sticks and other offerings for ritual purposes. To date, foot trails like those at Little Springs have not been located, suggesting that the heavy surrounding cinder blanket made movement into the flow interior a difficult undertaking, resulting in an area largely devoid of food and water resources. In contrast, the distance needed to leave the volcano-impacted zone at Little Springs was as short as a few kilometers, opening the interior of the lava flow itself to use and at least part-time or specialized settlement.

Comparison with modern cinder cone volcanoes indicates that it was unlikely that significant loss of life occurred as a direct result of the Sunset Crater and Little Springs eruptions. At Parícutin, where the eruption displaced thousands of people and destroyed hundreds of homes, no deaths were recorded from the lava or cinder fall itself (Luhr and Simkin 1993:7; Nolan 1979:328). The lack of volcano fatalities was due to two primary factors: the nature of the eruption itself and a family, or other small-scale, social organization. Because cinder cone volcanoes produce slow-moving fallout but no fast-moving pyroclastic currents like stratovolcanoes, lava emanating from the base can be outwalked, and evacuation of settlements can often occur in a planned and organized manner. Small-scale social group decision-making can also occur relatively quickly, due to the absence of hierarchical levels of authority above the group that must be consulted before a decision can be made.

The prehistoric groups at Sunset Crater and Little Springs were organized at a lower level of social complexity than at Parícutin, and it is reasonable to infer that household decision-making allowed for an extremely rapid response to the eruptions. Most importantly, the responses were highly dependent on the situation at hand, allowing for the incorporation of feedback, resulting in the formulation of unique, creative, and flexible modes of action. Varied responses are also highly adaptive, increasing the probability that if some are not successful, others will be.

Interpersonal violence can also play a role in volcano eruptions, potentially occurring if displaced groups are forced into territory claimed by others, which, due to resettlement by the Mexican government, happened in the Parícutin area. Land wars, caused by the covering of local territorial landmarks by tephra and the resettlement of Parícutin inhabitants into already occupied or claimed territories—and not

the eruption itself—accounted for the greatest loss of life associated with the eruption (Nolan 1979, 1993). Archaeological evidence for prehistoric violence is found around the time of the eruption in the Sunset Crater-Wupatki area (Elson 2006a, 2006b; Garcia 2004; Smith 1952; Turner and Turner 1990, 1999), but whether this violence was related to the eruption is unknown.

Differences in the nature of the two volcanic eruptions are reflected in the different adaptive mechanisms employed by the Sunset Crater and Little Springs groups. At Sunset Crater, variable depths of cinder deposition resulted in short- and long-term responses. A thick cinder blanket forced abandonment and migration of formerly agriculturally rich areas. Deposition of a thin layer of cinders, however, created water-retaining mulch and opened up new arable land in the arid, previously unfarmable, Wupatki area. New agricultural techniques—the cinder management described above—developed to ensure that a thin layer of cinders remained across agricultural fields. Given that the Wupatki area was occupied for around 150 years, these techniques were likely short-lived, with cinders blowing away or being worked into the pre-eruption soil within decades or centuries (see also Colton 1960). Soil depletion by intensive farming may also have eventually affected fertility, serving as an additional factor in the final abandonment (Anderson 2011).

At Little Springs, cinder deposition was rare and allowed post-eruption occupation to continue as it had prior to the eruption; only a 6 km² area under lava or lava bombs could not be reoccupied. While the lava flows may have displaced several hundred people, the small size of the flow suggests that previously established territorial boundaries were probably not a factor in resettlement. Day-to-day habitation occurred at the base of the flow, with the flow top most likely used as a defensive retreat.

The household level of social organization at Sunset Crater and Little Springs was advantageous in dealing with the eruptions (Sheets 2012). In many ways local populations were preadapted to deal with a natural disaster by having what modern hazards research describe as low “vulnerability” and high “community resilience.” These preadaptive factors include (1) small group or family-level decision-making allowed for a rapid response; evacuation was not predicated on information and directions coming from the top of the social hierarchy; (2) minimal energy was invested in architecture and site structure—construction of a new pit structure or small masonry pueblo could be accomplished in days or weeks with materials at hand; (3) an agricultural risk reduction strategy of small fields cultivated in different microenvironments meant that less energy was invested in each field and volcanic damage was likely variable; (4) a settlement system of dispersed, small sites with kin located across a wide area served as a safety net for affected individuals; and (5) the relatively small size of the Sunset Crater and Little Springs eruptions,

with tephra-free areas present within 5–30 km at Sunset Crater and 1–5 km at Little Springs, allowed migration into known areas.

Modern hazards research also provides a second measure of the impact of the Sunset Crater and Little Springs eruptions on local populations. Dennis S. Mileti, Thomas E. Drabek, and J. Eugene Haas list the characteristics of disasters that allow them to be ranked as to the severity of their impacts (Mileti, Drabek, and Haas 1975; see also Sheets and Grayson 1979b). These data indicate that the most severe and disruptive events are characterized by (1) a high degree of uncertainty; (2) sudden occurrence with little warning; (3) prolonged duration; (4) a broad scope of environmental, cultural, and human physical damage; (5) occurrence at night; and (6) survivors' exposure to the dead and injured. By this scale the Sunset Crater and Little Springs eruptions had moderate effects. As discussed above, numerous warning signs likely preceded both eruptions. Although the exact nature of an eruption was probably unknown, it was readily apparent that something was about to occur. Neither eruption had a prolonged duration and both were small, allowing easy migration (less than a day's walk) into unaffected areas. While the eruptions must have occurred at night for at least part of the time, there were probably few injuries or deaths, which is one of the most devastating variables.

Groups living near active volcanoes commonly incorporate eruption accounts into their traditional histories, and the ethnographic record is clear that ritual behavior by affected groups should be expected (Blong 1984; Nolan 1979, 1993; Plunket and Uruñuela 1998a, 1998b; Scarth 1999; Sigurdsson 1999). As noted above, volcano eruptions are commonly seen as signs of spiritual and moral transgressions, and offerings are made in an attempt to rectify these transgressions and avert the destruction. Today, seventy years after the Parícutin eruption, a large diorama outside a church in Nuevo San Juan Parangaricutiro, one of the volcano refugee relocation settlements, clearly shows the devil working a bellows that is fanning the lava as it flows from the top of the volcano. Perhaps most important for understanding prehistoric (and modern) eruptions, religious or cultural mechanisms for coping with a natural disaster can be highly adaptive, enabling affected individuals and groups to more readily accept the event and begin the recovery process (Nolan 1979). Although we do not know the religious significance of the Sunset Crater and Little Springs eruptions, the recovery of spatter agglutinate blocks impressed with corn (Sunset Crater) and containing sherds (Little Springs) is suggestive of volcano-related ritual. As the archaeological record attests, life at Little Springs appears to have continued largely unaltered by the eruption, while less than fifty years following the Sunset Crater eruption, volcano refugees constructed some of the largest and most complex pueblo sites ever built in the Flagstaff area.

ACKNOWLEDGMENTS

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Changing Landscapes of Early Colonial New Mexico

Demography, Rebound, and Zooarchaeology

EMILY LENA JONES

In 1972 Alfred Crosby coined the phrase “the Columbian Exchange” to describe the global disturbance that resulted when contact between Old and New Worlds increased in both frequency and extent. Crosby’s work opened a new field of research, one that combines history and biology to explore questions of cultural and environmental change—and one tied, at its roots, to historical ecology. As Ronald H. Towner (this volume) discusses, much of the work in historical ecology focuses on disturbance, a concept that has become increasingly important in studies of human-environment interactions (Balée 1993). Disturbances can be short-term (i.e., a fire or volcanic eruption [Elson et al., this volume]) or they can take place over long periods of time (as in indigenous burning regimes; see Roos et al. 2010); they can increase biological diversity or they can suppress it. But whatever else they do, they cause a pronounced change in an environment—in its functioning, its composition, or both.

The Columbian Exchange was a disturbance at a massive scale, both ecologically and culturally (e.g., Grennes 2007; Mann 2011; Nunn and Qian 2010). Although the changes were global, the effects of the Columbian Exchange were particular, impacting different environments in different ways. In North America, introduced diseases (O’Fallon and Fehren-Schmitz 2011; Ramenofsky 1987; Ramenofsky et al. 2003); reforestation of the Eastern Woodlands (Denevan 1992; Dull et al. 2010; Nevle and Bird 2008); depression of landscape structuring species like the North American beaver (*Castor canadensis*) (Naiman et al. 1988); and the introduction,

both deliberate (as in domestic animals) and not (as in earthworms), of new taxa (Frelich et al. 2006; Pavao-Zuckerman and Reitz 2006) all played, and continue to play, a role in restructuring the landscape.

In New Mexico this “great disturbance” seems to have followed a different trajectory than in many other parts of North America. Unlike the apparent situation in the Southeast (Pavao-Zuckerman 2007), many of the Old World domestic animals appear to have been adopted promptly by indigenous peoples across the Southwest (Gifford-Gonzalez 2011; Jones 2013; Pavao-Zuckerman 2011). Some of these new taxa became integral to indigenous identities in New Mexico as well as to Spanish Colonial lifestyles (Parezo 1996). Sheepherding in particular became an important part of some indigenous lifestyles, and horses transformed transport and subsistence choices (Hämäläinen 2010; White 1988).

Of course, the introduction of so many new animal species to New Mexico could be expected to have had environmental impacts as well—erosion and vegetation loss from those new grazers. The documentation for this kind of change in New Mexico is scant before the nineteenth century, though instances of overgrazing were noted by the Spanish farther south in the early colonial period (Esparza Sánchez 1996). Given the differences in population (of both people and cattle), it seems unlikely that New Mexico suffered the same sort of grazing impacts as seen in Zacatecas, though some environmental historians have inferred grazing impacts in New Mexico merely from the presence of the new animals (Bohrer 1975; Doebley 1984; List et al. 2007; Weisiger 2009). It is possible, however, that competition for graze may have impacted populations of indigenous artiodactyls, thus decreasing their availability for hunters.

Another difference between New Mexico and other regions in contact-era North America concerns catastrophic disease epidemics. Disease and, more broadly, demographic change seem to have played a different role in the Southwest than they did in eastern North America (Kulisheck 2003; Ramenofsky 1996). While disease did impact indigenous populations, its signature is neither as early nor as dramatic as in the Eastern Woodlands. Epidemic disease becomes evident in New Mexico in the seventeenth century rather than the sixteenth (Ramenofsky and Kulisheck 2013); and when disease did arrive, mortality does not seem to have been as high as it was in many other parts of the Americas (Barrett 2012; Kulisheck 2010; Ramenofsky et al. 2003). Because the decline in Native American populations in New Mexico was apparently less dramatic than elsewhere in North America, the resultant landscape transformation may also have been less extensive.

However, while New Mexico may not have had disease-related mortality as high as other regions in North America, disease did decrease indigenous populations at least somewhat (Barrett 2002b, 2012); in addition, the disturbance of European

contact and settlement spurred other demographic changes. Jeremy Kulisheck (this volume) makes the point that population and demography are different concepts, and patterns of migration and identity in New Mexico certainly changed with Spanish contact. One later example of this change is the emergence of *Vecino* identity (Eiselt and Darling, this volume), but such changes are evident in the record of the early colonial period as well. Spanish colonists brought with them significant numbers of sheep, goats, and cattle (Hammond and Rey 1953), changing the landscape and thus subsistence choices for Native Americans. On the missions, indigenous hunting was curtailed and farming and herding were encouraged instead (Spielmann et al. 2009). New settlement patterns emerged both among indigenous groups and the Spanish (Barrett 2002b; Ramenofsky and Feathers 2002); ethnic identities formed (Barrett 2012); and there were shifting trade relationships (Graves and Spielmann 2000).

All of these changes certainly affected the way people were interacting with their environments—and how they were using fauna. The addition of domestic livestock to the landscape coupled with increased human mortality and changing demographic patterns may have decreased indigenous subsistence-oriented hunting. At the same time the Spanish demand for hides may have contributed to an increase in hunting for trade (Spielmann et al. 2009). Such changes should be reflected in the zooarchaeological record. Zooarchaeology can thus provide a window into the demographic changes that occurred in contact-era New Mexico as well as its changing environments. Despite the important role of faunal resources in early colonial New Mexican landscapes, and the potential for this record to tell us about environmental change, the fauna from this time period has been relatively understudied. This chapter examines zooarchaeological patterns from early colonial New Mexico and explores what this record can tell us about changing landscapes, both biological and cultural, during this era of great disturbance.

DEPRESSION, REBOUND, AND THE LANDSCAPES OF CONTACT

The term *landscape* has its roots in geography, though it has come to be widely used in archaeology as well, particularly among archaeologists interested in human ecology. Landscape is the environment at the scale at which humans experience it; as Carl O. Sauer (1925) famously said, it is “the expression of interaction between humans and their environment.” Scale is thus an important part of landscape, as is the dynamic relationship between people and the natural setting in which they live. Landscape-level analysis thus typically involves the integration of data from different analyses to answer questions about human interactions across regions (Jones 2010). Zooarchaeologists commonly use two concepts, both drawn from Optimal

Foraging Theory, to explore changing faunal landscapes: resource depression and its converse, rebound.

Resource depression is rooted in the Prey Choice model of Optimal Foraging Theory; it refers to a situation where foraging efforts have resulted in declines in higher-ranked prey (Charnov et al. 1976; Stephens and Krebs 1986). Although I will not fully review the Prey Choice model here (see discussion in Lupo 2007), several points are key to understanding resource depression. The Prey Choice model assumes that resources are ranked along a continuum from high return to low return. Zooarchaeologists typically use the body-size proxy to rank resources, assuming that larger resources will provide a higher return than lower ones (Broughton et al. 2011; Ugan 2005). The forager's goal is to harvest sets of prey types that will maximize the overall return rate. Generally, if there is an abundance of higher-ranked resources available, then diets should be rich in those higher-ranked resources; if there is a scarcity of higher-ranked resources, then diets will be rich in lower-ranked resources.

Prehistoric resource depression has been documented in a wide variety of locations and is often used to infer human population growth, as increased populations of hunters would depress local animal populations (e.g., Butler 2001; Codding et al. 2010; James 2004; Jones et al. 2008; Lyman 2003; Nagaoka 2002). In late prehistoric North America, resource depression appears to have been extensive, particularly in the West (Broughton 1999; Broughton et al. 2010; Cannon 2000; Szuter and Bayham 1989). Although much of this work has emerged from hunter-gatherer archaeology—as the Prey Choice model was designed for foraging populations rather than agricultural ones—prehistoric resource depression has been identified in agricultural contexts in North America as well (e.g., Broughton et al. 2010; Cannon 2001; Dean 2007; Foster 2010).

Environmental rebound is the flip side of resource depression—a situation in which higher-ranked resources are recovering from hunting pressure, generally signaled by a relative increase in representation of higher-ranked prey. Rebound in contact-era landscapes has been inferred from historical documents (Denevan 1992; Martin and Szuter 1999) and botanical data; the reforestation of eastern North America, for instance, is well supported by pollen and macrobotanical evidence (e.g., Munoz et al. 2010; Nevle and Bird 2008), as is sixteenth-century landscape rebound in certain parts of Mexico (Fisher 2005). Given that resource depression was apparently so widespread in prehistoric North America, it is likely that higher-ranked faunal resources would have rebounded in tandem with the vegetation. The zooarchaeological record for rebound is somewhat ambiguous in southeastern North America (Foster 2010; Hogue 2003; Holm 2002; Pavao-Zuckerman 2007), but on the Pacific coast a trend of increasing relative abundance of higher-ranked faunal

resources is well documented (e.g., Coddington et al. 2010; Lyman 2003, 2006; McCoy 2008; but see Rick 2011; West 2009; Whitaker 2010). Some zooarchaeologists have suggested that this apparent rebound is the result of the increased indigenous mortality that occurred with European contact (Broughton 1999; Butler 2000).

The suggestion that contact-related demographic changes caused faunal rebound is an interesting one, but it has not been much tested; this is likely in part due to the difficulty of teasing out the impacts of the multiple factors that contributed to the great disturbance of contact. Rebound may occur if there is a decrease in human population, but it can also occur because people are hunting less—or it may occur for a combination of these and other variables. Contact-era New Mexico is a good example of this. Increasing relative abundance of higher-ranked prey during this time might reflect indigenous population decline (Barrett 2002b; Jones and DeWitte 2012; Ramenofsky 1996), but the direct influence of the Spanish on subsistence practice (missionaries encouraged indigenous peoples not to engage in long-term hunting trips) would have had a similar effect. Other possible (not mutually exclusive) factors include the Spanish demand for hides (Spielmann et al. 2009); changing indigenous subsistence practices for reasons unrelated to the Spanish (as in Jones 2013); the introduction of new forms of transportation (i.e., the horse); and the influence of changing settlement, both indigenous and Spanish, on mobility.

Teasing out the influence of one cause over another in this case is a challenge at the very least. The landscape change spurred by the Columbian Exchange was, by definition, multicausal (Mann 2011); the complexity of the situation in New Mexico is just one manifestation of this complex event. Rather than searching for a single cause, a better strategy might be to acknowledge that all these factors might be considered demographic changes in a broad sense, as they stem from changing migration and identity patterns; that all would likely have had an impact on peoples' hunting behavior; and finally, as we know these changes occurred and would have impacted hunting and thus landscape, we might expect to see rebound in the faunal record here, manifest as a relative increase in higher-ranked prey.

CONTACT-ERA LANDSCAPES IN NEW MEXICO

As in other late prehistoric landscapes in North America, it appears that indigenous populations in many areas of the Southwest were experiencing resource depression by the end of the fourteenth century. In this region higher-ranked prey would likely be artiodactyls: deer (*Odocoileus* sp.), elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), and, in some areas, bison (*Bison bison*). Lower-ranked prey might include lagomorphs (particularly cottontails, *Sylvilagus* sp.) and rodents (such as

prairie dogs, *Cynomys* sp.). Faunas from locations as diverse as the Northern San Juan region (Driver 2002), the Phoenix Basin (Dean 2007), and the Northern Rio Grande (Lang and Harris 1984; Schmidt 2008) show significant declines in artiodactyls relative to smaller prey in the late prehistoric period.

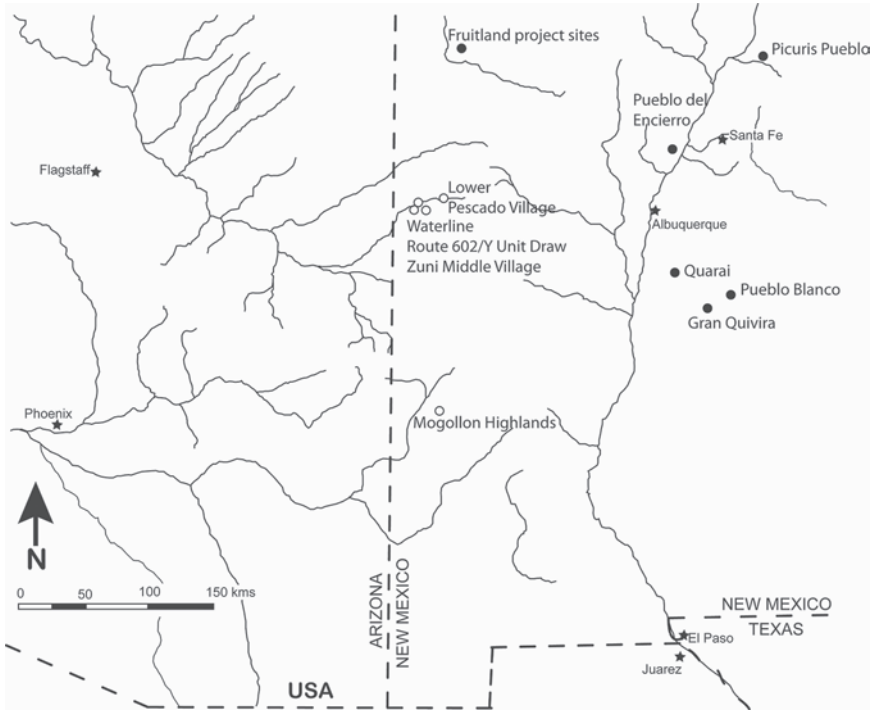
But is there any sign of rebound in postcontact New Mexico landscapes? I searched out published faunas from the early historic period in New Mexico to address this question (map 5.1). Assessing zooarchaeological data from early colonial period New Mexico is a challenge: there are relatively few zooarchaeological data sets, and of the data sets that are available, many were collected in different ways and/or contain only partial information. Combining data compiled with such varied approaches poses a number of methodological challenges (Atici et al. 2013; Lyman 2008). Many of the assemblages have not been subject to a taphonomic analysis, for example, so factors such as fragmentation, screen size, and agent of deposition may be influencing these numbers. In addition, the chronological resolution is different at different sites, making comparisons at a fine scale impossible. In this case, however, despite the diversity in context and the variability in the level of analysis, evidence for intensification of artiodactyl hunting was present at all of these sites. In most assemblages this intensification manifested as an increase in the relative abundance of artiodactyls in the early historic period. Even given the potential problems, the fact that this pattern is so ubiquitous—it appears across northern and central New Mexico, in regions from the Middle Rio Grande to the far northwestern corner—is both interesting and suggestive. If taphonomic and/or mechanical factors are at play here, such factors are clearly very widespread.

To better understand the factors that may be involved with these patterns, I explore the data from four projects—Picuris Pueblo, the Fruitland Data Recovery Project, Pueblo del Encierro, and the Salinas Pueblo missions—in more depth.

PICURIS PUEBLO

Herbert W. Dick conducted a series of excavations at Picuris Pueblo in the 1960s (Adler and Dick 1999; Dick 1965). The fauna from these excavations was a significant part of the collection, with assemblages covering the time period from AD 1225 through AD 1696; Arthur H. Harris identified and analyzed these collections. Harris's analysis suggests a decline in the relative abundance of artiodactyls prior to European contact, followed by a rebound after AD 1500 (Harris 1999).

I used Harris's data to explore the statistical significance of the increase he identified in the sixteenth and seventeenth centuries (figure 5.1). There is a clear pattern of increasing representation of artiodactyls through time, with a low of 40 percent in the fifteenth century and eventually rising to over 70 percent in the seventeenth



MAP 5.1. Locations of faunal assemblages considered in this analysis.

century. Cochran's test of linear trend, a chi-square based test, verifies that this increase is significant ($\chi^2 = 17.6, p < 0.0001$).

FRUITLAND DATA RECOVERY PROJECT

The 2002 Fruitland Data Recovery Project included a number of Navajo-affiliated occupations from the sixteenth- and seventeenth-century Diné and Gobernador periods (Hovezak et al. 2002). Timothy D. Hovezak and LeeAnn Schniebs initially analyzed these fauna (Hovezak and Schniebs 2002); I reanalyzed the zooarchaeological assemblage as part of a larger project in 2009 (Jones 2013).

Figure 5.2b shows the relative abundance of large prey specimens to the total number of identified specimens. The Fruitland assemblages were extremely fragmented, and much of the fauna was only identified to size class. There is a striking and significant increase in the relative abundance of large mammals between the Diné and Gobernador phases (Cochran's test of linear trend: $\chi^2 = 302.9, p < 0.0001$). While the timing of this increase—around AD 1650—is slightly later than

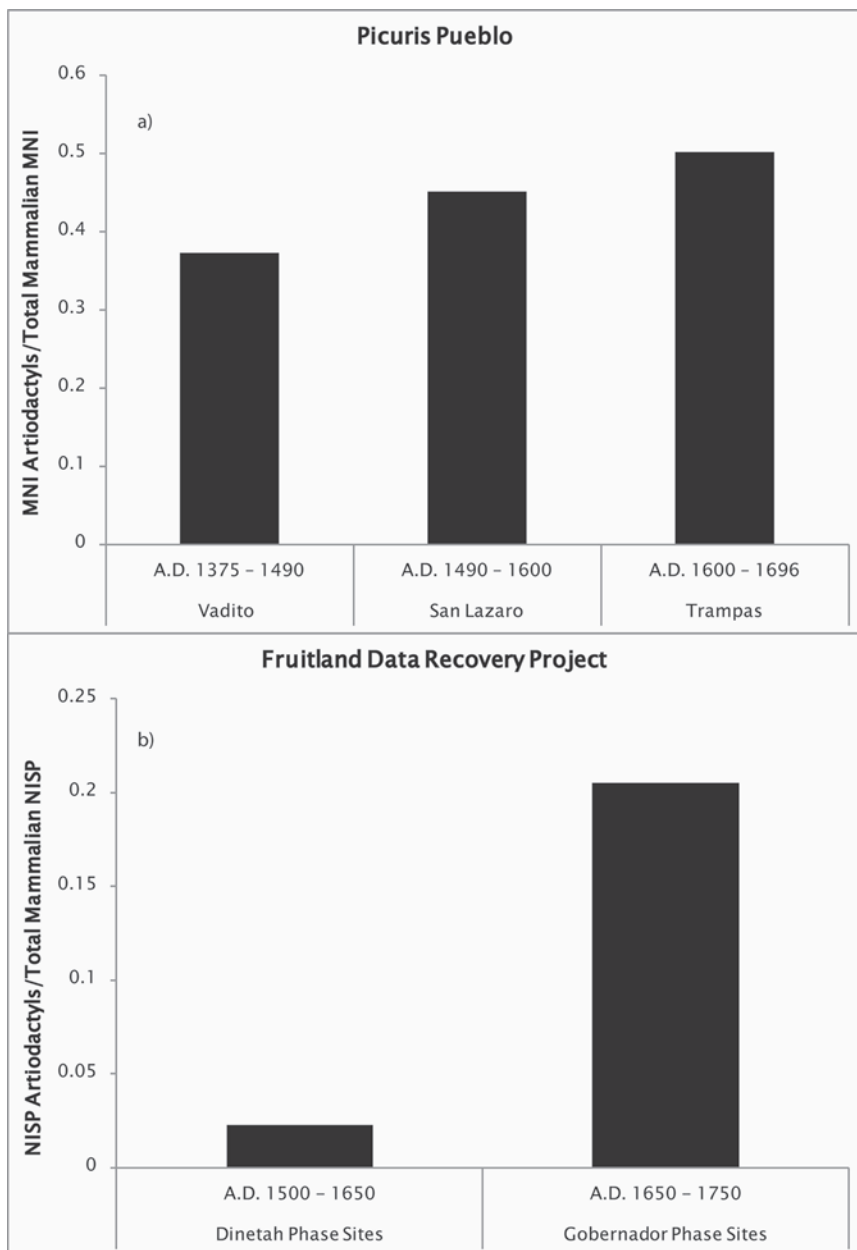


FIGURE 5.1. Relative abundance of artiodactyls at (a) Picuris Pueblo and (b) the Navajo-affiliated sites from the Fruitland Data Recovery Project, with Old World domesticates removed.

many of the other sites in this sample, it is appropriate given the later dates of contact in northwestern New Mexico.

In the course of my reanalysis, I tested for the influence of taphonomic and mechanical factors on the patterns in this assemblage. As mentioned earlier, factors such as differential fragmentation, different screen sizes, and intrusive rodents can influence the proportion of large and small prey in a zooarchaeological assemblage (Lyman 1994, 2008). However, even when taphonomic and mechanical processes were taken into account, a statistically significant pattern of increasing representation of large mammals, particularly artiodactyls, remained (Jones 2013).

OTHER SITES: PUEBLO DEL ENCIERRO AND THE SALINAS PUEBLOS

Two other assemblages provide an interesting counterpoint to the Fruitland and Picuris data. Harris (1976) analyzed the fauna from Pueblo del Encierro (LA 70). Although the sample size from this assemblage is small, the dates from this site extend further back into the fourteenth century, allowing a long-term view of subsistence use. Prior to the sixteenth century, artiodactyls are present only in very low frequencies. In the sixteenth century, however, they begin to rebound. The trend at Pueblo del Encierro is not statistically significant, which is unsurprising given the small sample sizes. This collection would, however, be a good candidate for a reanalysis.

The faunas from the Salinas Pueblo missions (Quarai, Gran Quivira, and Pueblo Blanco) show a different pattern of intensification than the other sites in this dataset (Spielmann et al. 2009). The Salinas Pueblos are unlike the other sites considered here in their geographic location (south central New Mexico; see map 5.1); they are also different in their proximity to Spanish settlement, as Quarai had an active mission, and at Gran Quivira there was minimally an intermittent Spanish presence in the seventeenth century (Spielmann et al. 2009). In addition, as has been discussed at length elsewhere, the Salinas Pueblos' location made them vulnerable to raids by nomadic populations (Barrett 2012).

Perhaps not surprisingly, these assemblages are also different in their faunal composition. At Quarai the relative abundance of artiodactyls actually decreases in the colonial period, while there is a slight increase at Gran Quivira and Pueblo Blanco, though not a significant one (Spielmann et al. 2009). However, Spielmann and colleagues did identify intensified use, particularly of pronghorn, at Pueblo Blanco and Gran Quivira, which they interpret as related to Spanish demand for hides.

The consistent Spanish presence may be one reason why the Salinas Pueblos' faunas display a different pattern (albeit one of intensification) than the other faunas in this study, but environment is likely a critical component of this difference

as well. Dendroclimatological work suggests that there was a local shift in climate in this location in the seventeenth century, with a major drought initiating during this time period (Parks et al. 2006). This drought may have depressed large mammal populations.

CLIMATE AND LANDSCAPE CHANGE

The Salinas Pueblos' faunas highlight the importance of climate in understanding shifts in relative abundance in large mammals. In this case a decrease in precipitation may have caused large mammal abundances to decline. The converse is also true: an increase in precipitation could potentially cause large mammal abundances to spike. If there was an increase in average precipitation in most parts of New Mexico during the contact period, then the increase in artiodactyl relative abundance seen at the other sites in the study might have resulted from that climate variability rather than changing human demography. In short, to infer demographic changes from changes in faunal relative abundance, we must demonstrate that changes in climate cannot be the ultimate cause of the rebound.

Most of the data on precipitation and climate for the Southwest is drawn from dendroclimatological records. While these high-resolution records are an excellent source of information, matching them to the coarse-scale chronological data available for the archaeological data in this sample presents a challenge. However, the increase in representation of artiodactyls seems to begin with Spanish colonization in the late sixteenth century/early seventeenth century. If increased precipitation were driving the increase, there should be a strong, consistent signal for a wetter period at this time across the Southwest.

A consideration of three dendroclimatological records from distinct regions—the San Francisco Peaks in northern Arizona (Salzer and Kipfmüller 2005); south central New Mexico, near Socorro (Parks et al. 2006); and the Pajarito Plateau (Towner and Salzer 2008)—suggests this is not the case (table 5.1). These records indicate remarkable variability throughout the early historic period, but there is not the strong, consistent signal in the late sixteenth/early seventeenth century that we would expect if precipitation were the cause of rebound. As the increase in relative abundance of large mammals is evident across a broad geographic space, precipitation does not seem a good candidate for the ultimate cause of this transition.

ENVIRONMENTAL REBOUND AND FAUNAL DIVERSITY

The pattern of increased relative abundance of artiodactyls at the contact period appears to be robust. Although additional taphonomic analyses of these faunas are

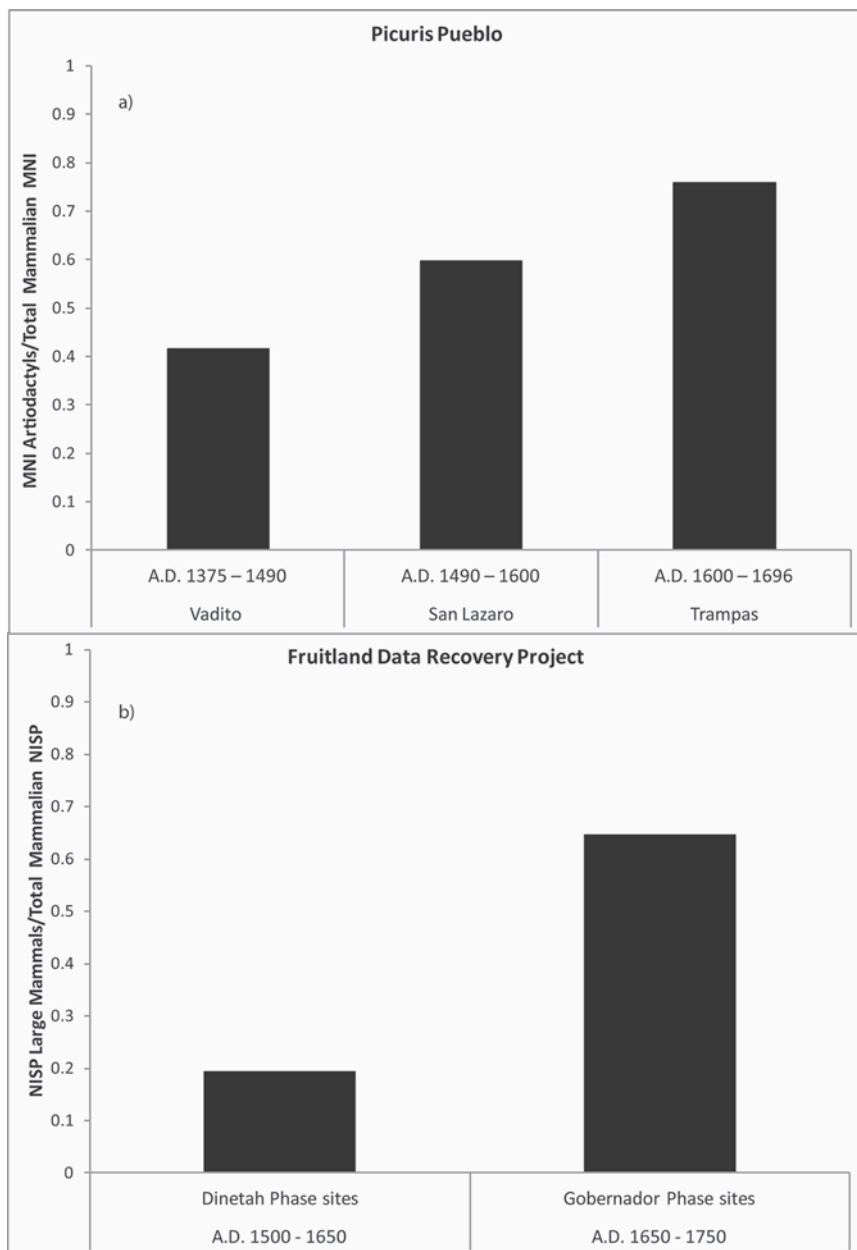


FIGURE 5.2. Changing relative abundance of higher-ranked prey at (a) Picuris Pueblo and (b) the Navajo-affiliated sites from the Fruitland Data Recovery Project.

TABLE 5.1. Summary of climate data from across the Southwest

<i>Years AD</i>	<i>San Francisco Peaks^a</i>	<i>South-central New Mexico^b</i>	<i>Pajarito Plateau^c</i>
1450–1500	Drier/Wetter	Variable	Drier
1500–1550	Wetter/Drier	Drier	Variable
1550–1600	Wetter/Drier	Drier/Wetter	Drier
1600–1650	Wetter	Wetter	Wetter/Drier
1650–1700	Drier/Wetter	Drier/Wetter	Wetter
1700–1750	Wetter	Wetter/Very dry	Variable
1750–1800	Wetter	Variable	Variable
1800–1850	Drier	Wetter	Drier

^aSalzer and Kipfmueller 2005; ^bParks et al. 2006; ^cTowner and Salzer 2008

desirable, the ubiquity and persistence of the pattern of increase suggests that the increase is, in fact, real, and not an artifact. Why, then, did this increase occur?

The first—and perhaps most obvious—explanation concerns the introduction of Old World domestic faunas. The initial Spanish settlers brought cattle, sheep, goats, and possibly pigs with them (Hammond and Rey 1953; Payne 1999). These taxa are all artiodactyls, and we know that both indigenous people and the Spanish used them (e.g., Brown 1999). The use of Old World domesticates could be what is driving the increase in the representation of large mammals.

To test for this possibility, I removed the Old World fauna from the analysis and then examined the relative abundances of mammals identified to genus or higher taxonomic resolution. Removing the domesticates from the analysis had no impact on the pattern (figure 5.2): there is still a statistically significant increase in the relative abundance of artiodactyls at both Picuris (Cochran’s: $\chi^2 = 23.8$, $p < 0.0001$) and Fruitland (Cochran’s: $\chi^2 = 84.2$, $p < 0.0001$). Introduced Old World domestic animals are not driving this pattern.

If, on the other hand, non-domesticated, native southwestern artiodactyls are better represented because they were increasingly abundant on the landscape, those native artiodactyls should be driving the pattern. Using the logic of the Prey Choice model, if there were increasing landscape availability of native artiodactyls, there should be decreasing overall faunal diversity in the zooarchaeological assemblages. As those higher-ranked resources became more available, people would have increasingly focused on those prey while lower-ranked, smaller prey items would be dropped from the diet. Quantitative measures of three aspects of diversity—nestedness, richness, and evenness—can be used to test this hypothesis.

TABLE 5.2. Hypothetical nested and not-nested faunas

	<i>Nested fauna</i>			<i>Not-nested fauna</i>		
	<i>Early</i>	<i>Middle</i>	<i>Late</i>	<i>Early</i>	<i>Middle</i>	<i>Late</i>
Deer (<i>Odocoileus</i> sp.)	+	+	+	+	–	–
Pronghorn (<i>Antilocapra americana</i>)	+	+	+	+	+	+
Jackrabbit (<i>Lepus</i> sp.)	+	+	–	+	–	+
Cottontail (<i>Sylvilagus</i> sp.)	+	+	–	–	+	–
Gunnison's prairie dog (<i>Cynomys gunnisoni</i>)	+	–	–	+	+	–

Nestedness describes order within ecological systems; it is used by ecologists to explore ecosystem structure (e.g., Bascompte et al. 2003) and, increasingly, by zooarchaeologists in optimal foraging approaches (Jones 2004, 2013; Lyman 2008). Nestedness measures the degree to which assemblages are subsets of each other, making it an ideal tool for zooarchaeological prey choice analyses, where resources are expected to be added to/dropped from the diet in ranked order. A hypothetical zooarchaeological example is illustrative (table 5.2). The nested assemblage (at left) shows decreasing diversity through time: the fauna from the “Late” period is a subset of that of the “Middle,” and both are subsets of the “Early” fauna. This nested distribution would be expected in a situation of environmental rebound: as larger prey types, like deer, become more available, we first lose the prairie dogs and then the lagomorphs. The not-nested fauna (at right), on the other hand, has no order. An assemblage such as this one suggests that some other factor or combination of factors—whether variable climate, a shift in subsistence strategy, or changing sample size—is driving the presence and absence of particular taxa.

The presence/absence matrix for the Fruitland data can be seen in table 5.3, and that for Picuris Pueblo in table 5.4. If these faunas were nested, we would expect most taxa to be present in earlier phases, with some absences of lower-ranked resources in later time periods. I used NED software (Strona et al. 2014) to calculate a nestedness metric called the NODF (Almeida-Neto and Ulrich 2011). The NODF measures nestedness from 0 to 100, taking into account both the richness of columns (in an archaeological sample, this is the richness of strata or units of time) and the richness of rows (in a zooarchaeological sample, this is the number of taxa represented). I also used NED to calculate respective standardized effect sizes as z-values based on 500 simulated null matrices. Null matrices were constructed using the “proportional row and column total” algorithm (Bascompte et al. 2003).

TABLE 5.3. Presence/absence matrix, Navajo-affiliated faunas from the Fruitland Data Recovery Project (Hovezak and Schniebs 2002; Jones 2013). The NODF for this matrix is 53.17 ($z = 0.75$, not nested).

	<i>Dinetah phase sites</i>	<i>Gobernador phase sites</i>
	<i>AD 1500–1650</i>	<i>AD 1650–1750</i>
Jackrabbits (<i>Lepus</i> sp.)	+	+
Cottontails (<i>Sylvilagus</i> sp.)	+	+
Prairie dogs (<i>Cynomys</i> sp.)	+	+
Kangaroo rats (<i>Dipodomys</i> sp.)	+	–
Porcupine (<i>Erethizon dorsatum</i>)	+	–
Pocket gophers (<i>Thomomys</i> sp.)	+	+
Woodrats (<i>Neotoma</i> sp.)	+	+
Deer mice (<i>Peromyscus</i> sp.)	+	–
Canids (<i>Canis</i> sp.)	+	+
Pronghorn (<i>Antilocapra americana</i>)	–	+
Deer (<i>Odocoileus</i> sp.)	+	+
Horse (<i>Equus</i> sp.)	–	+
Domestic sheep/goat (<i>Ovis/Capra</i>)	–	+

As might be expected from tables 5.3 and 5.4, neither of the faunas under consideration here is nested. The Picuris Pueblo fauna has a NODF of 62.46 ($z = 0.64$, $p > 0.05$) and the Navajo-affiliated faunas from the Fruitland Data Recovery Project have a NODF of 53.17 ($z = 0.75$, $p > 0.05$).

Richness and evenness, more commonly used zooarchaeological measures of diversity (Lyman 2008), likewise do not meet expectations for decreasing diversity through time. Richness, or the number of taxa represented in an assemblage (NTAXA), can be used as a measure of diet breadth (e.g., Grayson and Delpech 1998; Lyman 2008). In a case of increasing abundance of non-domesticates, we would expect NTAXA to decrease through time, as diets focus increasingly on those higher-ranked types. But this is not the case at either Picuris or Fruitland (table 5.5). In the Fruitland project data, there is no change at all in NTAXA; at Picuris there are changes, but the changes do not correlate with the relative abundance of large mammals. Rather, NTAXA in the Picuris assemblage seems to be a function of sample size.

This is, perhaps, not surprising; there are a number of known problems with using NTAXA as a measure of diet breadth, and sample size is one of them (Grayson and Delpech 1998; Lyman 2008). Dietary evenness, or the degree to which taxa are equally represented in an assemblage, can be another useful measure of diversity (Jones 2004; Lyman 2008; Magurran 2004). I measured evenness using the

TABLE 5.4. Presence/absence matrix, faunas from Picuris Pueblo (Harris 1999). The NODF for this matrix is 62.46 ($z = 0.64$, not nested).

	<i>Vadito</i>	<i>San Lazaro</i>	<i>Trampas</i>
	<i>AD 1375–1490</i>	<i>AD 1490–1600</i>	<i>AD 1600–1696</i>
Cattle or Buffalo (<i>Bos/Bison</i>)	+	+	+
Deer (<i>Odocoileus</i> sp.)	+	+	+
Pronghorn (<i>Antilocapra americana</i>)	+	+	+
Domestic sheep/goat (<i>Ovis/Capra</i>)	–	–	+
Bighorn sheep (<i>Ovis canadensis</i>)	+	–	+
Horse (<i>Equus</i>)	–	–	+
Domestic pig (<i>Sus scrofa</i>)	–	+	–
Elk (<i>Cervus elaphus</i>)	–	+	–
Jackrabbits (<i>Lepus</i> sp.)	+	–	+
Cottontails (<i>Sylvilagus</i> sp.)	+	+	+
Porcupine (<i>Erethizon dorsatum</i>)	+	–	+
Beaver (<i>Castor canadensis</i>)	+	–	–
Yellow-bellied marmot (<i>Marmota flaviventris</i>)	+	–	–
Pocket gophers (<i>Thomomys</i> sp.)	+	+	+
Woodrats (<i>Neotoma</i> sp.)	+	+	+
Gunnison's prairie dog (<i>Cynomys gunnisoni</i>)	–	+	+
Albert's squirrel (<i>Sciurus aberti</i>)	+	–	+
Rock squirrel (<i>Spermophilus variegatus</i>)	+	–	–

reciprocal of Simpson's index ($1/D$); the higher the value of $1/D$, the more “even,” or equally distributed, the fauna in the assemblage are. When $1/D$ is low, the fauna is uneven or dominated by just a few taxa. In a case of increasing landscape abundance of non-domesticates, we would expect $1/D$ to decrease, as diets focus on the higher-ranked prey types. There is little variation in evenness through time in either of these projects; the numbers are essentially the same (table 5.5).

In short, these assemblages show no change in diversity through time, whether diversity is measured through nestedness, richness, or evenness. Such a result might suggest that landscape rebound is not driving the increasing abundance of artiodactyls, but a careful examination of the presence/absence matrices (tables 5.3 and 5.4) provides important supplementary information. When we consider how these faunas changed through time, it becomes clear that the presence of Old World domesticates

TABLE 5.5. Richness and evenness values for the faunas from Picuris Pueblo and the Navajo-affiliated sites from the Fruitland Data Recovery Project

	<i>Vadito</i> <i>AD 1375–1490</i>	<i>Picuris Pueblo</i> <i>San Lazaro</i> <i>AD 1490–1600</i>	<i>Trampas</i> <i>AD 1600–1696</i>
NTAXA	14	9	13
1/D	1.28	1.24	1.24
<i>Fruitland Data Recovery Project</i>			
	<i>Dinetah</i> <i>AD 1500–1650</i>	<i>Gobernador</i> <i>AD 1650–1750</i>	
NTAXA	10	10	
1/D	1.35	1.39	

TABLE 5.6. Taxa gained and lost in the faunas from Picuris Pueblo and the Navajo-affiliated sites from the Fruitland Data Recovery Project

	<i>Vadito</i> <i>AD 1375–1490</i>	<i>Picuris Pueblo</i> <i>San Lazaro</i> <i>AD 1490–1600</i>	<i>Trampas</i> <i>AD 1600–1696</i>
N Artiodactyl Taxa	4	5	6
N Rodent Taxa	7	3	4
<i>Fruitland Data Recovery Project</i>			
	<i>Dinetah</i> <i>AD 1500–1650</i>	<i>Gobernador</i> <i>AD 1650–1750</i>	
N Ungulate Taxa	1	4	
N Rodent Taxa	6	3	

is influencing these numbers, even if it is not driving them. To use the Fruitland fauna (table 5.3) as an example: in the Gobernador, there are two additional domestics—horse and sheep/goat—as well as antelope. At the same time, three rodent taxa drop out of the assemblage. The Picuris data (table 5.4) show the same pattern: numbers of artiodactyls taxa increase through time while rodents decrease. A summary of taxa gained and lost can be seen in table 5.6. Losing rodent taxa is exactly what would be expected in a situation where higher-ranked prey types were becoming more available. What is obscuring this change in all three measures of diversity—richness, evenness, and nestedness—is the fact that there were also new high-ranked taxa on the southwestern landscape. So although there are increasing numbers of higher-ranked resources here, the landscape of available higher-ranked prey is becoming more diverse.

DEMOGRAPHIC CHANGE AND SEVENTEENTH-CENTURY NEW MEXICAN LANDSCAPES?

The data presented here, though necessarily coarse-grained, are suggestive. The predicted rebound signal of increasing representation of higher-ranked prey is present in New Mexican zooarchaeological assemblages from the contact era; there is a widespread transition from small-game dominant archaeological faunas to large-game dominant ones. Although more in-depth taphonomic work needs to be done on more of these faunas, both the ubiquity of the pattern and a pilot study with the Fruitland data (Jones 2013) suggest that the pattern is robust. Likewise, neither changes in precipitation nor the introduction of Old World domesticates are directly driving the shift.

The diversity data are less straightforward. Archaeological faunas do not become less diverse during this transition, but that seems to be a reflection of the more diverse faunal landscape rather than an indication of continued broad diets. Rodent richness decreases, as would be expected in the case of landscape rebound. The pattern of increasing representation of artiodactyls thus may reflect increasing availability of higher-ranked resources.

As discussed earlier, however, it is difficult to specify precisely which variables are driving this trend. Indeed, it is likely that explanation in this case is multicausal. Multiple variables may be contributing to this apparent increase in the landscape presence of artiodactyls. While increasing use of domestic artiodactyls has been ruled out as the driving factor here, many other hypotheses raised earlier in this chapter remain possibilities. Changes in demography, including but not limited to increased mortality and/or increased sedentism as a result of contact, may have led to a decrease in hunting, which in turn may have allowed for a rebound of higher-ranked prey. The differences in the Salinas Pueblo missions' faunas (Spielfmann et al. 2009) from the others in this sample suggest that variability in proximity to a consistent Spanish presence may be a critical factor in the patterning.

But technology is also an important consideration here. Higher-ranked resources can increase in availability as a result of decreased search costs—in other words, more efficient ways of going farther (Kelly 1995; Osborn 1983; Smith 1991). The introduction of the horse makes the issue of search costs an important one to explore. Likewise, technology can increase hunting efficiency, and we know that significant changes in technology occurred during contact as well.

The research presented here shows that in north and central New Mexico there is a significant transition in contact-era New Mexican zooarchaeological assemblages. Any of the factors discussed above—or perhaps most likely, a combination of them—might be driving the pattern of increase seen here. Demography, technology, and environment were all part of the great disturbance of European contact—and this

great disturbance is apparent in contact-era New Mexican archaeological faunas. While there is much work to be done to clarify and expand this record, the signature of change is there.

Cause and Explanation

Considering (and Reconsidering) the Role of Demography in Southwestern Archaeology

JEREMY KULISHECK

In common discourse, to say that an idea is taken for granted is to insinuate that it is a triviality. To say so in science, however, is a testament to that idea's embeddedness. As Ann F. Ramenofsky and Cynthia L. Herhahn point out in their introduction, demography and the related idea of population are suffused within contemporary explanations of historical change forged by archeologists for the US Southwest and Mexico's northwest (see also Ortman, this volume). As do Ramenofsky and Herhahn, I look to the twenty-five "grand challenges" for archaeological research recently identified by Keith W. Kintigh and others as a measure of the significance for understanding demographic and population change to answer the major research questions of interest to archaeology (Kintigh et al. 2014). Of the twenty-five listed, no less than eighteen implicate demography and population as variables critical for the development of explanation. And while the scope of Kintigh and colleagues is global, they identify the US Southwest as featuring an archaeological record most suited for addressing these challenges. Their identification of the Southwest as one of "our strongest empirical cases" is well founded (Kintigh et al. 2014:11). The American Southwest has an archaeological record that is ideal for the investigation of demographic change and population change in particular. George Cowgill (2000) has argued it may be the best place in the world to examine population change through the archaeological record.

In many parts of the Southwest, we have achieved the promise of examining population change at the scale of the lived human experience. Stephen Shennan (2000)

has argued that when population change can be observed on this scale, descriptions of culture change move from speculative to truly explanatory because there is a match between what we observe and what we seek to explain, allowing hypotheses to be tested and validated. This level of population reconstruction is made possible by two aspects of the southwestern archaeological record. The first is, of course, the high-precision tree-ring record that has allowed us to examine settlement occupation and settlement change on the scale of the lived human experience. It has allowed for the actual reconstruction of population at settlements that are well investigated (Dean 1970; Lightfoot 1994) and for the modeling of population at those that are not (Ortman 2012b; Ortman et al. 2007). The second is the sustained high level of research in the region that has made it one of the best investigated in the world. The Southwest has been the subject of probably the greatest academic interest among archaeologists in North America, but aspects of the record itself have lent to this sustained effort.

Much of the record lies relatively undisturbed by development, is on public lands, and is accessible for investigation. The presence on public lands means that where there is disturbance from development, research is mandated in advance of that disturbance. In some areas of the Southwest, much of what we know about population and population change is a consequence of that development-mandated research (Cordell 2005). In the Four Corners region, for example, a significant fraction of the research into the growth and movement of Athabaskan populations is from research in advance of oil and gas development (Wilshusen 2010). Similarly, ancestral Pueblo population growth and settlement distribution during the Developmental period in the Northern and Central Rio Grande has been largely defined by research conducted prior to highway construction (Lakatos 2007).

If the conditions of the southwestern archeological record are such that it is ideal for research into the size and structure of past populations, where are we currently situated? As Severin M. Fowles notes in Chapter 11, the reconstruction of demographic variables and population were explicit in explanations of culture change in the 1980s and 1990s. Demography and population are no less important today, as evidenced by their integration into the current major research programs focused on long-term historical change among Pueblo peoples (Hill et al. 2004, 2010; Kohler 2010; Nelson et al. 2010; Varien et al. 2007; Wilcox et al. 2007). However, as Scott G. Ortman points out in Chapter 7, there is little questioning of the centrality of these variables to most explanations of culture change. Population and demography as part of explanation is now mainstream. Given this, however, what the chapters in this section show is that demography and population should not be taken for granted. As such, we once again make these variables explicit. For the most part,

these chapters revisit familiar topics such as population reconstruction, paleodemography, and the examination of historic vital records. They are distinguished by their willingness to think and discuss differently about familiar themes in demography, whether it be through new techniques and approaches (Ortman, Stodder), attention to neglected data sets (Kamp), or the reframing of traditional categories of social organization (Eiselt and Darling, Fowles). Before discussing the context of these chapters within current southwestern archeology, however, it is important to revisit basic demographic principles and their place in the examination of cause and explanation.

DEMOGRAPHIC PRINCIPLES

The term *demography* is in common usage in southwestern archaeology but often finds overly broad application that dilutes its explanatory power. My objective here is to apply some specificity to the term so that its role in cause and explanation can be better identified. Most important to understanding demography is its distinction from the related concept of population. Population refers to the number of people—within a site, a region, alive during a particular moment of time, and so on. It is the totality of individuals we seek to enumerate or estimate. Demography, by contrast, defines the structure and composition of that population and the forces that contribute to changes in population size and structure. A population's structure refers to the variability of its constituent parts: its age composition, who is young and who is old, and the numbers of males and females within that population, among other attributes. It is important to maintain a distinction between the two, particularly when thinking about culture change.¹ This is because demography also encompasses the forces that drive population change. So when we talk about population change, we are talking about changes in the size of a population. When we refer to demographic change, by contrast, we are talking about the forces responsible for that change. It is a difference between what has changed and how it has changed. Demographic variables wholly determine the size of populations and how they grow or diminish. If we do not articulate explanations with these variables, we will get explanations of population change wrong.

All demographic change takes place within three variables: fertility, or birth; mortality, or death; and migration. Populations grow because more persons are born, fewer people die, or people immigrate from other populations. Populations shrink when fewer people are born, more people die, or people emigrate to other populations. All explanations of change in either the size or the structure of a population must be connected to the variables of fertility and mortality, and

most must also incorporate migration (Pollard et al. 1990). When we subdivide populations according to cultural categories such as ethnicity, race, and religion, most explanations of population change must also incorporate a fourth variable: identity. Identity has two dimensions. The first is the most intuitive, which is how people subdivide themselves into groups through self-identification with a particular group or how others identify them. As exemplified by the experience of Native Americans as a racial category, this form of identification can significantly influence population change. According to US Census records, in the period between 1910 and 2010, persons identified as American Indian (the Census Bureau category) grew by over 1,000 percent, about four times as fast as the US population as a whole and far greater than could be accounted for by gains in fertility (figure 6.1) (Norris et al. 2012; Ogunwole 2002; Shoemaker 1999). Migration cannot also be a factor, as Native Americans are, by definition, not immigrants or descendants of immigrants. The role of identity is implicated by the fact that this tremendous increase was initiated in 1960, the first census decade that individuals were allowed to self-identify their race on census questionnaires. The following decades saw the rise of the civil rights movement and, along with it, a transformation in the perception of Native American identity. What was a source of shame fifty years ago is now a point of pride, and the numbers of persons willing to identify themselves as Native American has grown significantly, resulting in a quintupling of the Native population relative to the US population as a whole (Shoemaker 1999).

The assignment of identity plays out somewhat differently in archaeological investigation, where identity is either assigned or inferred by the investigator based on material record traits. Identity may be drawn broadly, such as the distinction between mobile and sedentary groups based on settlement pattern. Or it may be identified more narrowly by material culture attributes we consider to be associated with ethnic identity: ceramic and projectile point styles, settlement configurations and layouts, and rock art styles, for example (Huntley, this volume). Here is where potential explanations get tricky. When indicators of a particular ethnic identity decline while population remains constant, is there replacement through immigration from other peoples outside, or are we witnessing autochthonous changes in identity? Or are we incorrectly associating identity with material culture traits that are changing in frequency for other reasons? Or, more subtly, are we failing to engage the definition of identity on the terms of those in the past responsible for those identities we think we see? This matter is unsettled in southwestern archaeology, as several of the chapters in this section indicate (Eiselt and Darling, and especially Fowles).

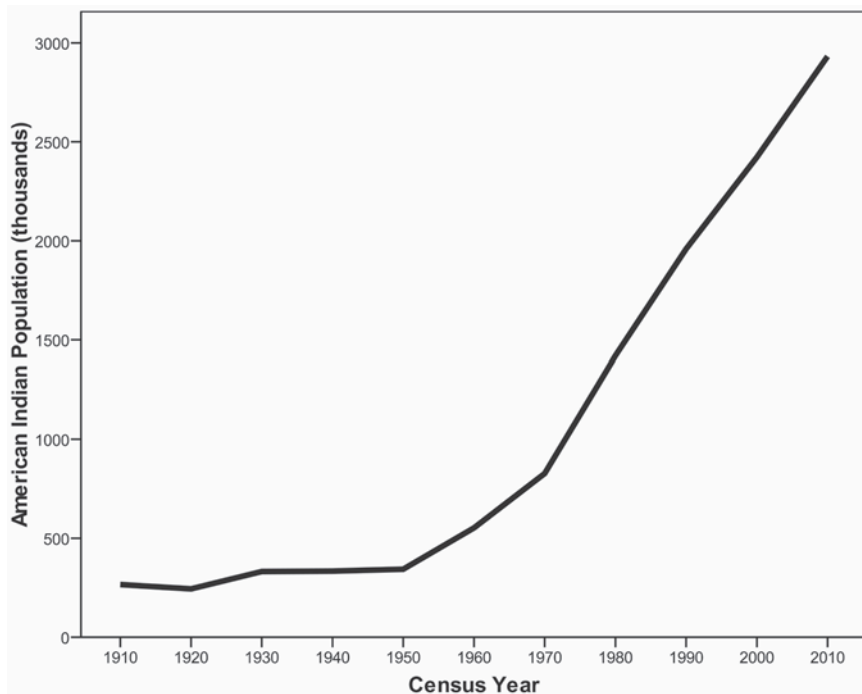


FIGURE 6.1. Growth of the Native American (American Indian) population in the United States.

DEMOGRAPHY, POPULATION, CAUSE, AND EXPLANATION IN SOUTHWESTERN ARCHAEOLOGY

In crafting explanations using demographic variables, the determination of population size receives priority. If we get the size of past populations wrong, then all explanations of population change, and explanations reliant on population change, will also be wrong (Nelson et al. 1994). This is a nontrivial matter, because inferring population size from the archaeological record is one of the most difficult tasks that archaeologists undertake. So argues Ortman in the first chapter in this section (as does Fowles in Chapter 11). In particular, Ortman states that absolute, rather than relative, estimates of past populations are necessary for population to be robustly integrated into explanations. Ortman has little use for relative population estimates. While I disagree with him regarding their limited utility (see Kulisheck 2010), I cannot but agree that absolute population estimates allow for the exponential improvement of many explanations and are indispensable for others.

The challenge is to craft population estimates that are accurate, a challenge identified two decades ago by Ben A. Nelson, Timothy A. Kohler, and Keith W. Kintigh. In their survey of population estimation by southwestern archaeologists to that point, they found that while researchers readily found proxies for population in the archaeological record, they seldom correlated these proxies with numbers of people in any accurate way (Nelson et al. 1994). The estimation of absolute population size is fundamentally about identifying the correct relationship between the number of people at any momentary time in the past with the quantity of some aspect of the archaeological record (such as the number of ceramic sherds or the floor area of structures) in the present. This field of inference is much more narrow than what is required for observing relative changes in population size or density, which can be inferred indirectly from a broader array of archaeological phenomena. Nelson, Kohler, and Kintigh highlighted some of the critical methodologies that are necessary to associate accurate numbers of people with archaeological proxies, and some progress has been made in crafting more credible population estimates. In particular, attention has been paid to calibration for unequal and variable spans and degrees of settlement occupation (Varien and Mills 1997; Varien and Ortman 2005).

What distinguishes Ortman's approach in this chapter from earlier prescriptions for accuracy in population estimation is that rather than being prescriptive, he describes the concepts that define what is necessary for crafting accurate population estimates. (He pays less attention to the precision of estimates, as southwestern archeologists are more attuned to a lack of precision and typically discard imprecise estimates as non-explanatory, even though they might be accurate.) While Ortman describes specific methodologies, his purpose is to demonstrate tools general enough so that they can be applied to data sets derived from a variety of proxies and of varying quality. For example, he discusses the need to adjust for variable population levels at settlements with long occupations. The need for such adjustment has been recognized by southwestern archaeologists since the 1970s (Plog 1975; see also Crown 1991) but has been unevenly applied. Ortman notes that variable occupations in his data set (of large villages from the Classic and early Colonial periods in the northern Rio Grande region) seem to best fit a model based on a logistic curve. However, he recognizes that variable occupations can take different shapes, and regardless of the shape, researchers must take it into account to achieve any degree of accuracy in their data set.

The second chapter in this section also concerns methodology, but like Ortman's chapter, it is fundamentally concerned with explanation. In reviewing the bioanthropological literature from the Southwest, Ann L. W. Stodder observes that the concern with using skeletal data to construct life tables (distributions of age and sex) has neglected the systematic examination of skeletal information relevant to morbidity, which constitutes the most prevalent component of skeletal pathology.

Until now, the treatment of morbidity has been largely anecdotal, despite its implications for quality of life and the attendant implications that quality of life issues have for explanations of culture change (Hegmon et al. 2008; Larsen 2002; Nelson et al. 2010). This lack of consideration is due to the absence of suitable frameworks for associating pathologies and the morbidity they indicate with quality of life indices. Stodder rectifies this problem by applying the Global Burden of Disease model—which quantifies the impact of injury, disease, and disability on individuals and communities—to data from skeletal pathology. The results are striking in the picture they paint of ancestral Pueblo communities distinct from life table data.

Stodder compares data on pathologies from two communities: the Pueblo I settlement of Ridges Basin in the Northern San Juan Basin, and the Pueblo IV (Classic) village of San Cristobal in the Galisteo Basin area of the northern Rio Grande region. While life tables show the same mean age at death within the two communities, the disability burden at the earlier settlement is much higher using Global Burden of Disease indices. This pattern defies the general assumption that quality of life should decline with greater reliance on agriculture and settlement aggregation. But it emphasizes a central theme that Stodder wishes to highlight: that the individual histories of communities in the past were quite variable, despite regional or long-term trends, and this variability is meaningful for explanations of historical change at the community and regional scale. Measuring disability burdens has a second effect. It describes the humanity of past lives in a way that typical demographic data does not—by describing the realities of past hardship at the scale of lived human experience (see Hegmon et al. 2008) and reminds readers that people populated the past (see also Fowles, this volume).

The next chapter in this section, by Kathryn A. Kamp, also deals with how an expanded view of examining demographic variables can provide meaning to the variability seen in larger trends. Kamp takes as her point of departure the masterful study by Kohler and others that employs paleodemographic data to identify the Neolithic Demographic Transition in ancestral Pueblo history (Kohler et al. 2008). Kohler and his colleagues observe that the data indicate that despite the introduction of maize in the Southwest approximately 4,000 years ago, a broad increase in fertility did not take place until between 2,000 and 1,500 years ago, coincident with the adoption of ceramic containers, reduced mobility, and an implied dependence on farming for subsistence. In their introduction to this volume, Ramenofsky and Herhahn observe that explanations are scale dependent. Kamp does not challenge the broad pattern observed by Kohler and his colleagues but does note that the wide variability within time periods observed in their data set belies other factors that influence fertility beyond subsistence strategy. Instead, past parents, particularly mothers, had a high degree of control over their fertility and adjusted family sizes

based on their evaluation of the costs and benefits of having children. Influenced by local conditions, these decisions about family size (and the effects of quality of life issues on fecundity, see Stodder's chapter) were much more influential in driving historical change at the level of the community. For example, Kamp observes that the duration of breastfeeding likely increased in Pueblo communities through the Ancestral Pueblo era, likely in response to deteriorating nutritional conditions for infants and small children. This greater duration of lactation would have reduced fecundity and encouraged parents to increase their birth spacing, reducing fertility. Again, this trend runs in opposition to the expectation that the duration of breastfeeding would decrease with an increasing reliance on agriculture for subsistence. It may also contribute to the process of coalescence that has been seen by several groups of researchers, who observe that this same period—from AD 1150 to 1400—was one of population decline (Varien et al. 1996; Hill et al. 2004).

B. Sunday Eiselt and J. Andrew Darling's chapter in this section examines the interplay between identity, ethnogenesis, and demographic change in the Southwest's Hispanic community during the eighteenth and nineteenth centuries. Their conclusion reverses the conventional wisdom regarding the relationship between identity and population growth. They conclude ethnogenesis was causal. The formation of a new New Mexican *Vecino* identity facilitated a pattern of population growth following a century of demographic instability, when the community's size was maintained only by forced immigration (the taking of slaves). In particular, the return to growth took place when identity became reconfigured around shared values rather than descent.

The demographic instability experienced by the Southwest's Hispanic population of the eighteenth century mirrored the experience of its Pueblo population in the same century (Palkovich 1996), and these parallels allow Eiselt and Darling to provide useful insights on other periods of ethnogenesis from polyethnic roots, where the type of vital records they employ are lacking (Bernardini and Fowles 2011; Wilshusen 2010). The themes that they address—population instability, frequent movement, depopulation, and reoccupation—are recurring in southwestern history and are not limited to the Colonial and National periods. In particular, the impact of ethnogenesis on settlement pattern and configuration is particularly telling.

The last chapter in this section, by Severin M. Fowles, brings us full circle. Fowles takes a critical theory approach to the use of population estimates and their application to explanations of social and political change. In their recent volume on the use of statistics in the analysis of indigenous demography, Maggie Walter and Chris Andersen point out that while all quantitative methodologies are theory laden, this reality enhances their use rather than giving a reason for their discard. Statistics can be trustworthy, even if they cannot be objective (Walter and Andersen 2013).

Fowles agrees, and rather than taking a wholly post-processual approach to Pueblo demography and social change, he forges a critical processualism to construct a narrative of southwestern history in one portion of the region. Fowles examines the social change that is indicated by dramatic changes in settlement in the Taos area in the eleventh through fourteenth centuries. Like Ortman, Fowles has internalized the critique of Nelson et al.'s use of "available" data for creating population estimates and instead pursues estimates that account for the total potential regional population (Nelson et al. 1994). But even with better numbers, Fowles does not assume that population size alone can be explanatory of social change.

Instead, Fowles emphasizes the importance of identity, ethnicity, and social role in determining how a population might be subdivided into the relevant groups through which the effects of changing population sizes might influence social change. Unlike Eiselt and Darling, Fowles has no direct access to information about the ethnic identities of his population of interest but is able to use direct historical and archaeological approaches to construct strong inferences about the ethnic diversity of the late Ancestral Pueblo population of the Taos area. Given this, he notes that the process of aggregation takes place in the context of coalescence rather than population growth. As such, he argues that, in contrast to previous interpretations—but in line with others (see Bernardini 1998)—aggregation served to facilitate competition reduction but was not likely undone by the same forces that brought it together. Instead, historical forces, intertwined with the ethnicity and identity of village occupants, likely created conflicts unrelated to demographic stresses.

In sum, the exploration of population and demographic issues has resulted in a series of chapters that present new ideas, methods, and explanations. Even when familiar topics are covered, such as the measurement of population size or density, solutions push us to think more creatively about the concepts employed to address how and why questions. The range of data sources employed is broad, with thoughtful and deliberate efforts to include parts of communities typically neglected or underrepresented in our inferences. Finally, these papers suggest that we are pushing epistemological boundaries in our effort to more exactly match archaeological knowledge to the lived experience of individuals, families, communities, and regions.

NOTE

1. It should be recognized that my division of population size and the variables of fertility, mortality, and migration is somewhat artificial and intentionally rhetorical. Andrew T. Chamberlain (2006), for example, treats population size as simply another demographic variable. I segregate population size due to the tendency of some southwestern researchers to treat population size as the only demographic variable.

Why All Archaeologists Should Care about and Do Population Estimates

SCOTT G. ORTMAN

Estimating the populations of settlements and regions is a critical element of contemporary archaeology. Whether one's research focuses on evolution, ecology, migration, social organization, or any number of other processes, knowing how many people were involved in a given episode of past behavior is an essential component of any compelling claim about it. Population is also a prerequisite for studies of past demographic processes (see Kulisheck, this volume), and actual numbers are essential if one wishes to compare archaeological data from different parts of the globe or contribute to our understanding of human social dynamics in general (see Huntley, this volume). Yet despite their obvious importance, translating the archaeological record into population requires estimates for a number of parameters, such as the relationship between surface and subsurface remains, the production spans and accumulation rates of artifacts, the amount of roofed space per person, the use-life of structures, and the growth patterns of settlements (Powell 1988). Although many of these parameters have been studied cross-culturally or in specific contexts, there are few situations in which the full suite is well controlled (see Fowles, this volume). As a result, many researchers either avoid making population estimates altogether or produce relative estimates while refraining from translating these into actual numbers of people.

In this chapter I argue we should take this next step and estimate actual population numbers, and the best response to the challenges involved is to put more effort into research that improves the precision and accuracy of such estimates. In the

first part of this chapter, I illustrate that actual population numbers are essential for continued progress in all three of the topic areas emphasized in this volume (see Ramenofsky and Herhahn, this volume) through presentation of concrete examples. In this first part I will not focus on how population estimates are derived but on the difference they make for interpretation. Then, in the second part I suggest several strategies for improving the reliability of population estimates, including treating artifact assemblages as accumulations, seeking out calibration data for needed parameters, continuing to improve pottery chronologies, and developing means of attaching uncertainties to estimates. My hope is that this chapter will convince readers that estimating population is something every archaeologist should worry about and that the best way to improve the accuracy and precision of these estimates is to design research that improves control over the underlying data and parameters.

AREAS WHERE POPULATION MATTERS

Absolute population estimates are not essential for all areas of archaeological research, but there are a number of areas where the absence of absolute estimates creates barriers to progress. One such area is migration and movement (see Huntley, this volume). Traditional archaeological approaches to migration have emphasized the identification of an intrusive material culture complex that can be traced back to a definable homeland (Haury 1958). Although such evidence typically indicates migration, the converse is not necessarily true: the absence of intrusive material culture does not necessarily indicate the absence of migration. Because people typically use material culture to express affiliation or distinction, depending on their interests in particular situations (Carr and Neitzel 1995; Conkey and Hastorf 1990; Hodder 1982; Stark 1998; Wiessner 1983; Wobst 1977), continuities in material culture only occur when the migrants determine it is in their interest to express their homeland identity in the destination area (Clark 2001, 2004; Lipe 2010; Ortmann 2012c; see also Huntley, this volume).

Analysis of regional population history is one of the alternative methods that can suggest migration when material culture continuities are ambiguous. Although many aspects of migration cannot be inferred solely from population estimates, one would expect significant population movements to be reflected in population curves, with complementary shapes *and magnitudes* for the putative source and destination areas. In addition, the inference of in-migration is much stronger when one can demonstrate that population growth in a region exceeds the maximum potential fertility of human populations (see, for example, Varien et al. 2007:figure 5B). Finally, population estimates are essential if one wishes to move beyond the

identification of migration to the study of its nature and consequences. For example, it is often useful to know the ratio of immigrants to indigenes in the destination area when interpreting the associated patterns of change in material culture, including the formation of hybrid or coalescent communities (Huntley et al., this volume).

One often needs to estimate actual numbers for both the source and destination areas to test migration hypotheses and estimate the social impact of such movements. This is because migration typically involves movement between regions, and the best methods for estimating population often vary across regions. Comparison of relative population curves can be suggestive, but complementary magnitudes, as well as shapes of time-series data, are most helpful. For example, in my work on the role of migration in Tewa origins, I reconstructed the population history of the Tewa Basin in north central New Mexico and compared it to the population history of the Village Ecodynamics Project (VEP) area in southwest Colorado. This comparison suggested that the thirteenth-century migration from the Mesa Verde region played an important role in the formation of ancestral Tewa society (Ortman 2012c; figure 7.1 below). Although I did not estimate population for the entire Northern Rio Grande or the entire Mesa Verde region, the complementary shapes and magnitudes of the resulting curves demonstrate that enough people were leaving the Mesa Verde region at the right time to have been a primary source of the ancestral Tewa population. This finding does not prove migration by itself, but the absence of complementary population histories would have disproved it. It is also important to note that the methods used to produce these two curves were different. The Tewa Basin estimates used room counts and associated pottery types for recorded sites, village growth models derived from excavation results, occupation span estimates for small sites from artifact accumulations, and extrapolations from surveyed areas within sampling strata; whereas the VEP estimates used pit structure counts, more sophisticated Bayesian methods, and a simple extrapolation from surveyed areas to the entire study area (Ortman et al. 2007; Varien et al. 2007). If only relative measures of population had been produced in either case, these comparisons would not have been feasible. Proportionate changes in population are only meaningful with respect to some absolute population size.

A second area where actual numbers matter is historical ecology, or long-term human-environment interactions (see Towner, this volume). Many studies have interpreted directional changes in settlement location, the plant species used for construction and fuel, the sizes of faunal elements, or the declining relative abundance of faunal species as evidence of resource depletion (Badenhorst and Driver 2009; Kohler and Matthews 1988; Minnis 1985; Redman 1999; Rollefson and Köhler-Rollefson 1992; Schollmeyer 2005; see also Jones, this volume, for discussion). This is one possible explanation, but the same patterns may also result from

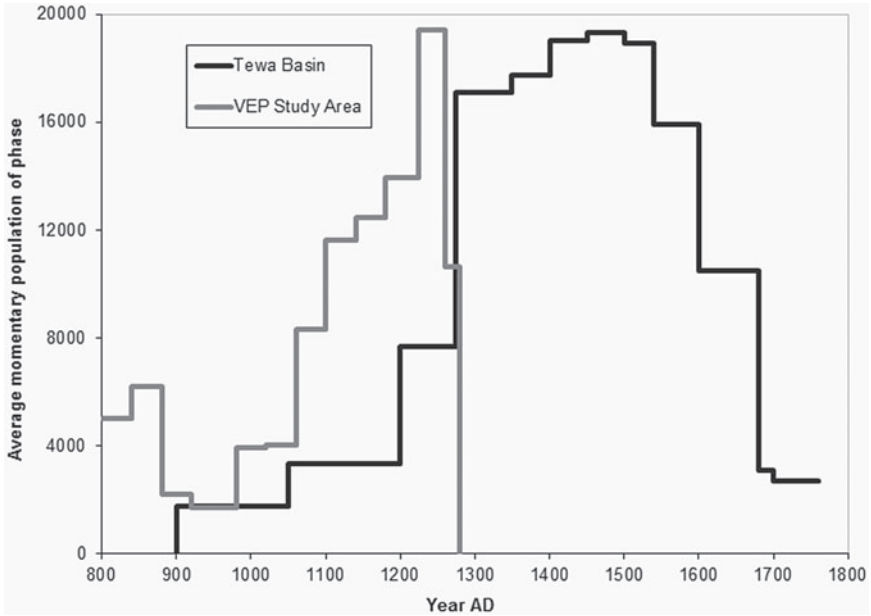


FIGURE 7.1. Population histories of the Tewa Basin and the Village Ecodynamics Project Area (after Ortman 2012c:figure 4.8).

climate change, technological innovation, or changing human preferences (see Towner, this volume). Given the range of possible explanations for such patterns, one way to determine whether resource depletion is a plausible explanation is to estimate the per capita use rate of a given resource, its regeneration rate, and the number of people that were consuming it in a given context. Here again, relative population curves are inadequate because there is no way to use these to determine whether the demand for the resource actually outstripped its productive or regenerative capacity.

Because such models minimally involve resource consumption rates, production rates, and population patterns, evaluating resource depletion hypotheses in a rigorous way involves systems of partial differential equations or some form of computer simulation. The VEP offers one example of such research. Several previous studies of faunal remains in the VEP area have noted declines in the relative abundance of deer bone and a corresponding increase in turkey bone (Badenhorst and Driver 2009; Muir and Driver 2002). The VEP investigated these findings in three ways: simulating study area deer populations based on ecological and environmental data; developing an agent-based simulation in which agents need animal protein for

optimal health and procure this meat through hunting; and estimating the actual population history of the study area (Johnson et al. 2005; Kohler et al. 2012; Kohler et al. 2007; Kohler and Varien 2012). These studies demonstrate that, at population levels comparable to the estimated human population during the early settlement cycle (AD 600–920), humans would have depressed deer populations. These results therefore support the hypothesis that the decline in relative abundance of deer remains, and the corresponding increase in turkey remains, was, in fact, driven by the depression of deer populations that in turn led to changes in hunting strategies and intensified production of domesticated turkey as a meat source.

A third area where absolute population estimates are essential is comparative research on scale and complexity. A range of studies has found significant correlations between the absolute population size of human settlements and their complexity, as measured in economic or political terms (Adler and Wilshusen 1990; Carneiro 1967; Chick 1997; Kosse 1990, 1994; Naroll 1956). As one of the most intensively studied archaeological regions in the world, the US Southwest is often included in debates on the emergence and collapse of social complexity and the degree to which social evolution is an appropriate model for these processes (Lekson 2009; Pauketat 2007; Tainter 1988; Yoffee 2005). To identify social, cultural, or historical regularities of any kind, one must translate the archaeological record into measures that can be compared across traditions. Total population size, settlement population size, and population density are three such measures that allow direct quantitative comparison and analysis.

To offer just one example, figure 7.2 compares the population history of the VEP area in Colorado, the Tewa Basin in New Mexico, and the Valley of Mexico. The VEP and Tewa Basin estimates derive from my previous work (Ortman 2012c; Ortman et al. 2007; Varien et al. 2007), and the Valley of Mexico estimates derive from the settlement pattern surveys conducted by the University of Michigan in the Chalco-Xochimilco, Iztapalapa, Texcoco, and Zumpango regions (Parsons et al. 1983). I translate absolute regional populations into population densities based on the arable land in each region and present the sequences with respect to the initial colonization date by agricultural peoples for each region. Thus, the zero date for the VEP and Tewa Basin histories corresponds to 600 AD and the zero date for the Valley of Mexico corresponds to 1400 BC (following Sanders et al. 1979:93).

The ceramic chronology of the Valley of Mexico is of much coarser resolution than is typical in the US Southwest, so the population history of the former probably appears much smoother here than it was in reality. Nevertheless, there is a striking correspondence between Valley of Mexico and VEP population histories for the first six centuries of occupation in each region. In fact, the Valley of Mexico history looks remarkably close to a moving average of the VEP history for this period.

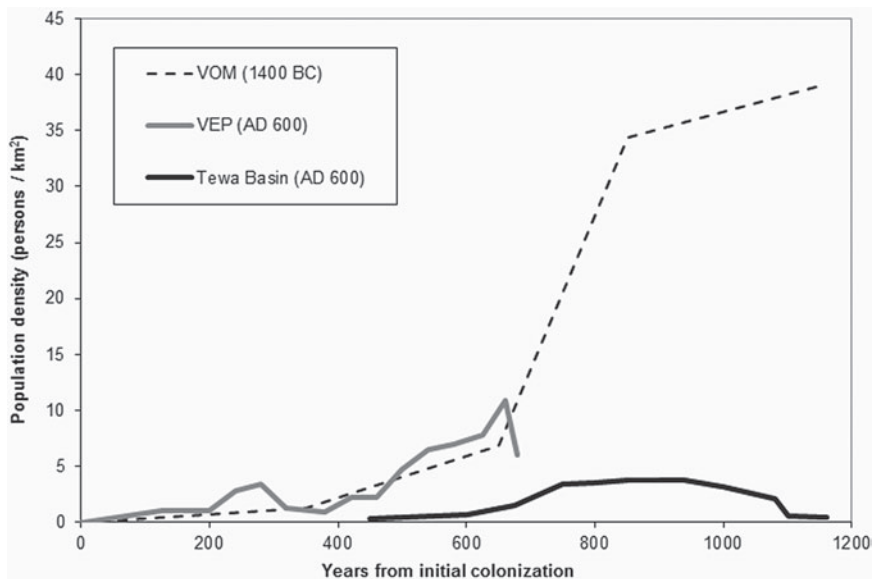


FIGURE 7.2. Population densities in the Valley of Mexico (VOM), the VEP area, and the Tewa Basin.

These data suggest that, for the initial six centuries, the VEP area developed along a similar trajectory to that of the Valley of Mexico. But the VEP system collapsed during its seventh century, and if my view of what happened next is correct, a large portion of this population moved to the Tewa Basin, where they contributed to a new system in which the overall population density was somewhat lower than it had been in the core VEP area. In the Valley of Mexico, in contrast, the next pottery period is the one in which monumental temples, regional centers, and class stratification emerged (Steponaitis 1981, 1984).

Population was estimated for the Valley of Mexico using a completely different method than is typical in the US Southwest. In these surveys fieldworkers (1) outlined the scatter of sherds characteristic of a given time period on aerial photos; (2) estimated the density of such sherds within the scatter; (3) correlated these sherd densities with population densities based on sixteenth-century documentary evidence; and (4) multiplied the areal extent of the scatter by the corresponding population density. These methods have been questioned, but recent work indicates the resulting estimates are consistent with those produced using architectural evidence at well-preserved sites in the area (Ortman et al. 2014). So, comparing these results with those from the Southwest appears feasible. In fact, we have no choice: the only

way we can compare ancient societies quantitatively is to translate the archaeological record into parameters that were common to both—in this case, people. It is good estimates, not the methods used to produce them, that matter. In the absence of good estimates, there is no way to make progress on the fundamental issues that are the focus of this volume and no way for archaeology to address the grand challenges highlighted in recent work (Kintigh et al. 2014; Smith et al. 2012). In this case my comparison suggests the Pueblos of the US Southwest and the urban societies of the Valley of Mexico had similar beginnings but took strikingly different paths at a certain critical point about six centuries after each society was established. Such comparisons lead to a host of interesting questions about the ways in which human societies change over long periods. And here, as elsewhere, absolute population estimates are the starting point.

HOW TO IMPROVE POPULATION ESTIMATES

The examples developed above illustrate that absolute population estimates are essential for certain questions. Of course, the conclusions reached in these examples depend on reasonable population estimates for individual settlements and regions, and significant changes in these estimates would change the interpretations in every case. One could respond to this situation by arguing that it is premature to offer population estimates when the necessary parameters are not well controlled. I disagree. I think a population context is so crucial for making progress on such a wide range of problems that we have no choice but to produce the best estimates we can, given the available data and methodologies. However, this perspective also means that estimating population is not a one-shot deal. One should put continuous effort into improving the underlying data and methods on which population estimates are based and periodically revisit previous estimates as knowledge of specific archaeological contexts improves. In the second half of this chapter, I describe several directions one might pursue in the interest of improving the reliability of population estimates.

Before doing so, it is necessary to say a few words about how one translates the archaeological record into population. The fundamental data typically consist of measures of the inhabited areas of individual sites and measures of the intensity of occupation at each site through time; and the parameters needed to translate these data into population include the mean inhabited area per person, the mean rate at which the relevant archaeological remains accumulate per person-year, and time periods defined by chronologically sensitive artifact types. The specifics of the data and parameters used vary widely across archaeological contexts. As examples: inhabited areas and per capita use of space can be quantified in terms of roofed area (Brown

1987; Cook and Heizer 1968; Maschner and Bentley 2003; Naroll 1962), structure counts (Dickson 1979; Kintigh 1985; Orcutt 1999), room block length (Wilshusen and Blinman 1992), house counts and composition (Lightfoot 1994; Ortman et al. 2007; Varien et al. 2007), sleeping arrangements within structures (Blakeslee 1989), or overall site areas and population densities (Johnson 1987; Sanders et al. 1979; Wright 2001); the intensity of occupation can be measured using accumulations of artifacts (Nelson et al. 1994; Varien 1999b; Varien and Ortman 2005), structural remains (Duwe 2011), or absolute dates (Berry 1982; Eighmy 1979); and time periods can be defined by just about any artifact type. What all these methods share, however, are problems associated with the accuracy and precision of the required data and parameters. Thus, if we wish to improve the reliability of population estimates, there is no alternative but to improve the accuracy and precision of the data and parameters involved. In the following pages, I suggest four directions in which archaeologists could work.

Treating Assemblages as Accumulations

The first useful direction is to treat artifact assemblages as accumulations. The artifact assemblage at every archaeological site resulted from the discard of various artifact types over a period of time (Schiffer 1987; Varien and Potter 1997). To the extent that a consistent proportion of the population regularly used certain artifacts, there will be a direct relationship between the accumulation of these artifacts and the person-years of occupation. Mark D. Varien has taken advantage of this relationship to estimate the typical discard rate of cooking pottery in ancestral Pueblo sites (Varien 1999b; Varien and Mills 1997). These analyses allow one to estimate the household-years of occupation at individual sites by combining this discard rate with estimates of the total artifact accumulation (Ortman 2000; Varien et al. 2007) and to estimate occupation spans of specific sites by combining these household-years estimates with site size information (Varien 1999b; Varien and Ortman 2005; Varien et al. 2007). These studies play an important role in the population estimates developed for the VEP because they allowed us to control for differences between the lengths of the modeling periods in our study and the typical occupation spans of houses. Early in the Ancestral Pueblo sequence, modeling periods were of longer duration than the typical occupation spans of houses, and houses in villages tended to be inhabited for more years than houses in smaller farmsteads. In order to estimate momentary populations for these periods, we multiplied the total households inhabited at some point during each modeling period by the ratio of house occupation span to the modeling period length for various site sizes and periods. We also determined that such correction was not necessary for later periods because house occupation spans were generally longer than the modeling periods by that time.

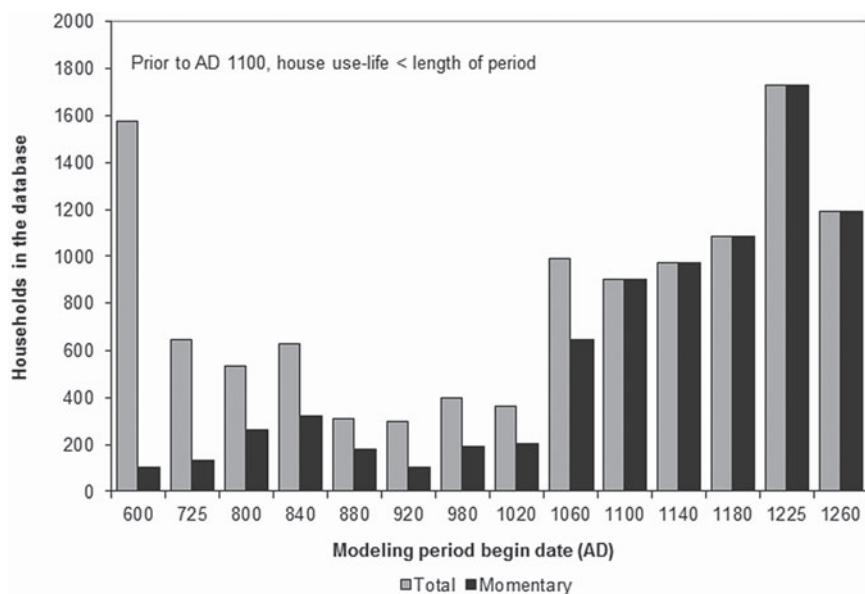


FIGURE 7.3. Total and momentary populations in the VEP site database.

These corrections for house occupation span make a substantial difference in our results. For example, the single most common type of ancestral Pueblo habitation site in the entire VEP site database is a single-family Basketmaker III (AD 600–725) farmstead. The initial modeling period in our study corresponds to the entirety of the Basketmaker III period and is thus 125 years long, whereas accumulations suggest Basketmaker III pithouses were only inhabited for 8 to 15 years (Cameron 1990, 1993; Varien and Ortman 2005). As a result, the momentary population of this period is actually the lowest of the entire sequence, despite the extreme abundance of sites dating to this period (see figure 7.3).

An accumulations perspective also helps one understand why, despite its long history of use for placing sites in a temporal sequence, seriation is not a very effective approach for estimating the population histories of settlements and regions. Robert C. Dunnell (1970) pointed out long ago that a seriation only represents a chronology when the assemblages involved accumulated over comparable time spans. The artifact assemblages at many sites do not meet this requirement, and thus, it is problematic to interpret seriations of such assemblages in chronological terms.

I illustrate this point using Yellow Jacket Pueblo, a large Ancestral Pueblo village excavated by Crow Canyon Archaeological Center between 1994 and 1997 (Kuckelman 2003). To reconstruct the population history of this site, I first

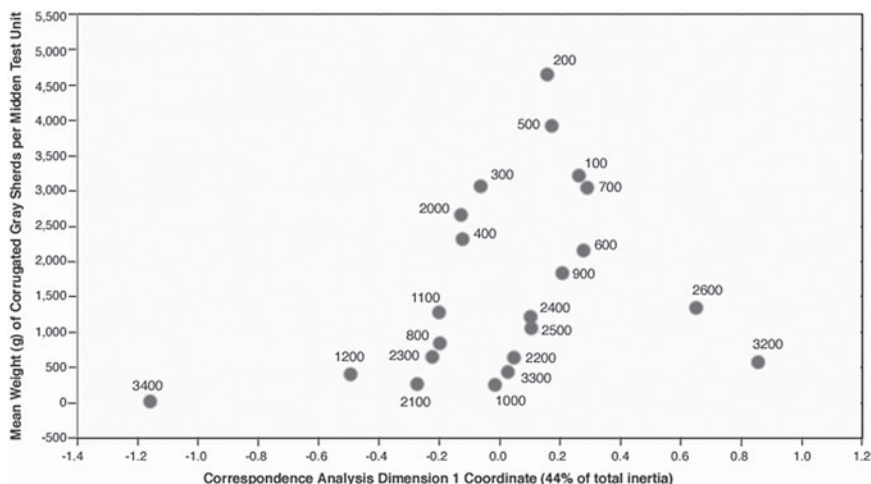


FIGURE 7.4. Correspondence analysis and midden accumulations, Yellow Jacket Pueblo (redrawn from Ortman 2003:figure 4).

examined cooking potsherd accumulations in a number of roughly contemporaneous small sites nearby (Varien 1999a) and found that the total weight of cooking potsherds in midden test pits is strongly correlated with the total cooking potsherd accumulation per household and, thus, the occupation spans of these sites. Then, I used this relationship to estimate the occupation spans of architectural blocks at Yellow Jacket and found that they varied from less than a decade to more than two centuries (Ortman 2003; Varien and Ortman 2005). Finally, I performed a correspondence analysis of typological and attribute data from decorated potsherds in these same test pits to determine whether variation in these assemblages marks the passage of time and, if so, how this sequence corresponds to the suggested deposition span of each assemblage.

Figure 7.4 presents first axis loadings from a correspondence analysis of the decorated pottery assemblage from each architectural block at Yellow Jacket on the x-axis and the mean weight of cooking potsherds from associated midden test pits on the y-axis. Analysts typically assume that most of the variation between pottery assemblages is due to the passage of time, and thus, the first axis from a multivariate analysis captures the chronological sequence of these assemblages. However, this interpretation is problematic in this case because architectural blocks with intermediate loadings on the first axis are associated with a wide range of occupation spans, whereas architectural blocks at either end have uniformly short occupation spans. In other words, some of the block assemblages fall in the middle of the putative

seriation because they were inhabited only during the middle years of occupation at the site, whereas others fall in the middle because they were occupied for long periods and thus have assemblage profiles that look “average” overall. So, which of these architectural blocks were inhabited during any given period? Seriation does not provide any answers in situations like this, where various areas of a site, or different sites in a region, were inhabited for varying lengths of time.

These sorts of problems have led me to use various forms of probability density analysis to characterize the population histories of Yellow Jacket and other sites. I have already presented several studies using such methods (Ortman 2012a, 2012b; Ortman et al. 2007; Varien and Ortman 2005) and spare readers a detailed treatment here. The critical point is that the improvements such methods provide derive from the fact that they treat artifact assemblages as accumulations. Specifically, probability density analysis accumulates the chronological significance of each artifact in an assemblage based on the probability that that artifact was deposited during a given period. These probabilities are in turn derived from prior knowledge of the production histories of artifact types. Ideally, one will have a number of well-dated, single-component assemblages to work with in specifying these production histories, as was done for the VEP (Ortman et al. 2007). But even when such data are not available, one can characterize production histories using normal distributions, as in mean ceramic dating, or uniform distributions that make no assumptions about the shapes of those histories. I believe approaches that combine uniform distributions with Bayes’ Theorem are best in situations where the production spans of various types are known but the shapes of the production curves are not (see Ortman 2012a, 2012b). The best solution, however, is to seek out additional calibration data, as I explain below.

Seek Out Calibration Data

A second useful direction is to seek out data for calibrating the various parameters involved in population estimates, including the production histories of pottery types, accumulation rates, structure use-life, relationships between roofed space and people, and the typical growth patterns of settlements. One example from my research on Tewa origins involved estimating the typical growth pattern of villages. Several studies of population history in the Northern Rio Grande have estimated the populations of villages that were inhabited for long periods by dividing the total roofed space at a site by the number of pottery periods represented by the occupation (Dickson 1979; Maxwell 1994; Orcutt 1999). This approach essentially assumes living space accumulates horizontally in these settlements. Consequently, the occupancy rate of the total architectural footprint at each site is no greater than the inverse of the number of periods of occupation. The effects of this procedure

are to reduce the peak populations of villages substantially and to average out their populations over time.

In my study of Tewa Basin population, in contrast, I assumed that nearly the entire architectural footprint of most Tewa Basin villages was inhabited at some point. Excavations at numerous sites—including Te'ewi (Wendorf 1953:61), Howiri (Fallon and Wening 1987), Sapawe (Snow 1963), and Tsama (Greenlee 1933)—support this generalization. This pattern of full occupancy of the site footprint during the final phase of occupation also appears to be characteristic of earlier and smaller sites, including Area 1 at Burnt Mesa Pueblo (Kohler and Root 2004), Palisade Ruin (Schroeder 1981), Kapo (Luebben 1953), and Nake'muu (Vierra et al. 2003). Finally, although the two components at Arroyo Hondo are superimposed, and the first appears to have been larger than the second, Winifred Creamer (1993:152–53) estimated that nearly all the rooms associated with each component were inhabited near the end of each occupation, with a period of abandonment in between.

In addition, several considerations also led me to conclude that the typical growth pattern of most Tewa Basin villages was better approximated by a logistic or S-shaped curve than by a steady-state model. For example, Robert M. Schacht (1980) reviewed literature in cultural ecology to show that logistic curves best capture growth in systems where populations approach local carrying capacities. This appears to have been the case for many large Tewa Basin villages. Agricultural features—including check dams, cobble-bordered grid gardens, and gravel-mulched plots—are also common and extensive around these sites and appear to have improved local farmland by retaining runoff and soil, absorbing heat and radiating it onto crops on cool evenings, and retaining soil moisture beneath the gravel mulches (Anschuetz 1998, 2005; Bugé 1984; Marshall and Walt 2007; Maxwell and Anschuetz 1992:61–66). These constructed fields represent substantial intensification in food production and investment in particular plots of land. This, in turn, suggests land pressure slowed the growth of settlements as they approached limits provided by technology and the local environment.

Other kinds of evidence also support the assumption that the growth patterns of villages typically followed S-shaped curves. Jeffrey Eighmy (1979) showed that logistic curves provide the best fit to cumulative distributions of tree-ring dates in thirteen of fourteen well-dated sites, including Arroyo Hondo and Pindi in the Tewa Basin, with an average $r^2 \geq .95$. This same pattern is apparent if one uses rooms rather than tree-ring dates as the index of growth. For example, William M. Graves (1983) used tree-ring dates in combination with architectural data to date the construction of each room at Canyon Creek Ruin and found that the resulting cumulative distribution of rooms in use in this cliff dwelling was closely approximated by a logistic curve.

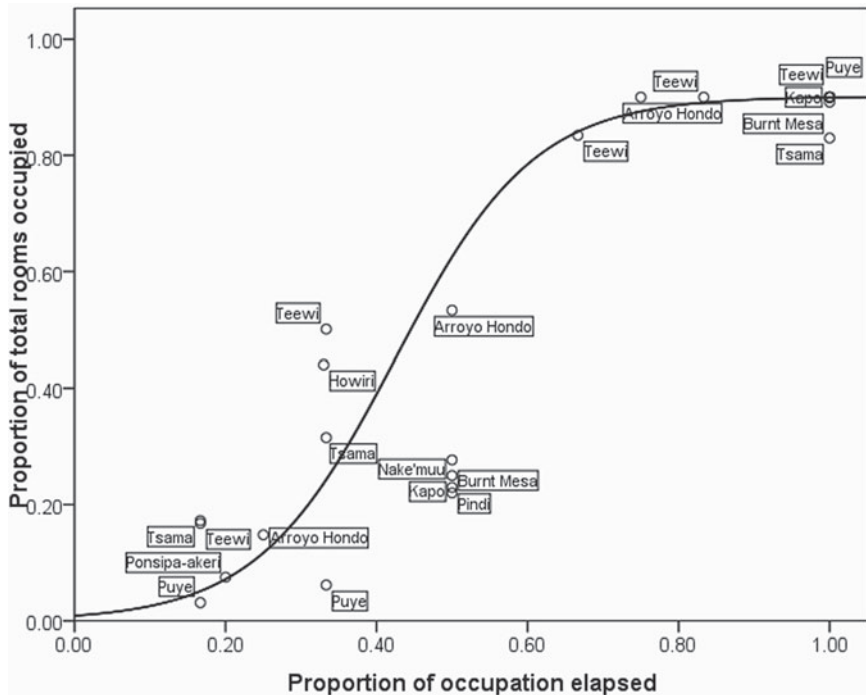


FIGURE 7.5. Typical growth pattern of Tewa Basin villages (redrawn from Ortman 2012c:figure 4.5).

Based on these theoretical and empirical observations, I decided to model the growth of Tewa Basin villages as having followed a logistic pattern, with nearly the entire footprint having been occupied during the final period of occupation. In order to estimate the shape of the typical growth curve, I compiled a data set of Tewa Basin villages for which occupied-room estimates are available for more than one period in the overall development of the site. I standardized these data to reflect the proportion of the total rooms inhabited and the proportion of total phases elapsed for each phase estimate, and I set the maximum proportion of occupied rooms at 90 percent following Creamer's (1993:152) suggestion for Arroyo Hondo. I then fit a logistic curve to the resulting data. Figure 7.5 presents the regression I used to derive a logistic growth function that estimates the proportion of total rooms occupied at various points in the occupation of a site.

This curve does not characterize the growth pattern of all villages (see Creamer 1993; Ortman 2012b; Ramenofsky et al. 2009), and models that allow the population histories of villages to deviate from the logistic pattern would be even better;

but this approach is still an improvement over previous approaches. And even if the logistic pattern misrepresents the population histories of certain sites, I believe it leads to a more realistic regional population history overall. Previous studies building from uniform assumptions have suggested the Tewa Basin population peaked in the Early Classic period and then gradually declined from that time through the Pueblo Revolt (Dean et al. 1994). In contrast, the logistic growth approach suggests the Tewa Basin population was fairly stable from the late 1200s through the early 1500s (figure 7.1). These differences are directly attributable to the different models of typical village growth used. Using the steady-state averaging method, the peak population occurs during the period when the greatest number of sites was occupied. The logistic growth method, in contrast, suggests that the growth of settlements inhabited for long periods was sufficient to account for the populations leaving shorter-lived settlements, and thus, a stable regional population simply aggregated into fewer, larger settlements over time (also see Kulisheck 2010). This makes an obvious difference for one's view of ancestral Tewa adaptations.

Improving Artifact Chronologies

Because population estimates ultimately depend on artifact chronologies, identifying and maximizing the use of chronologically sensitive artifacts is a third important strategy. Crow Canyon's current work on the Basketmaker III period illustrates this well. As I mentioned earlier, previous work by the VEP found that the single most common type of ancestral Pueblo site in the area is a Basketmaker III hamlet containing one or a few pit structures. Yet the momentary population of this period appears to have been the smallest of the entire Ancestral Pueblo sequence because the Basketmaker III period is 125 years long, whereas houses dating to this period only lasted eight to fifteen years (see figure 7.3). This means that, over the course of the period, each family lineage could have built, inhabited, and abandoned nine to sixteen pithouses that look contemporaneous. To determine how many people "seeded" this landscape around AD 600 or how fast the population actually grew, one needs to assign unexcavated sites to shorter time intervals within the Basketmaker III period.

The best way to solve these kinds of problems is to identify new ways of subdividing the archaeological record into shorter time intervals, and this is our current focus. The VEP calibration data (Ortman et al. 2007) show no obvious differences in the typological profiles of pottery assemblages dating to the early versus the late 600s, but previous research (Blinman 1988) suggests that the ratio of seed jars to other vessel forms may provide a means of assigning unexcavated sites to refined chronological periods. Preliminary research using tree-ring dated collections suggests we may well be able to exploit this attribute to subdivide the Basketmaker III

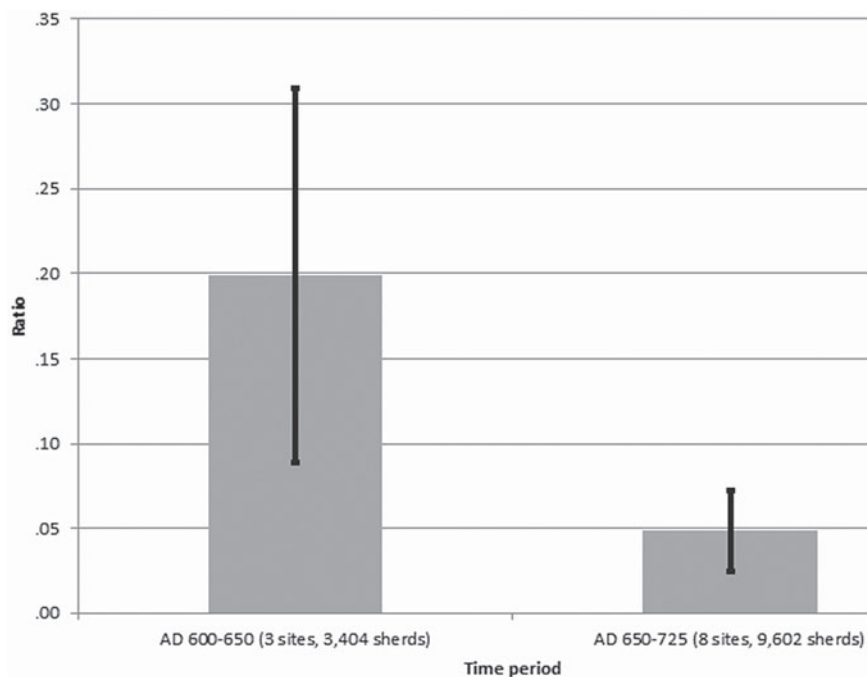


FIGURE 7.6. Ratio of seed jar sherds to all jar sherds in tree-ring dated Basketmaker III sites.

period into an early and a late phase (figure 7.6). We are also investigating whether sherd-to-flake ratios, percentages of nonlocal materials, or storage features might also date Basketmaker III sites more precisely. This would dramatically improve our ability to assess demographic processes associated with the initial colonization of the region. The point here is that, even if a lot of culture-historical work has been accomplished in a region, additional chronological indicators that could dramatically improve population histories may still be lurking. It is important to design research that finds them.

Quantify and Reduce Uncertainty

Finally, a fourth area in which much more work is needed is in devising ways of quantifying the uncertainty surrounding population estimates. Researchers have made some modest attempts at quantifying uncertainty in the past. For example, a common practice has been to produce a high and a low population estimate to bracket the range of possibilities. In the Valley of Mexico surveys, for example, surveyors estimated population density ranges for various settlement types using the ethnohistoric record and then applied the upper and lower bound of this range to

each site area to produce a corresponding population range (Parsons et al. 1983). The resulting ranges are often too imprecise to be useful, thus forcing researchers to select the midpoint of the range as the most likely point estimate. It would clearly be preferable to use measures of the mean and standard deviation of population densities for various kinds of settlements than work from overall ranges. Such measures would allow one to establish confidence intervals (CIs) around their estimates.

The VEP also made a modest attempt at quantifying uncertainty by estimating the total population of the study area using three different methods (Varien et al. 2007). These methods included (1) calculating the proportion of households living in community centers within block survey areas and using this figure to extrapolate the populations of small sites associated with centers outside block survey areas; (2) stratifying the study area into quadrants and elevation zones and extrapolating from household densities in block surveys within each stratum to estimate the total population; and (3) extrapolating small-site household densities within block surveys to the unsurveyed portion of the study area and adding to this the total households in community centers, which are assumed to be completely known. We ended up concluding that method 3, which produces estimates in the middle of the range, was most reasonable. But in reality we do not know whether our preferred method is more accurate than the others and we could not figure out how to produce CIs to evaluate the relative precision of each method. Rather, our approach quantified our uncertainty only informally, and it would clearly be worthwhile to develop a better means of producing both reasonable and rigorous CIs for our preferred estimation method in future work.

The challenge for quantifying uncertainty with respect to population estimates is that each of the parameters involved in such estimates has its own degree of uncertainty, and compounding error leads to CIs that are so broad as to be practically useless in most cases. One solution to the problem is to continue seeking out data for estimating each parameter in the hope of reducing its associated uncertainty; or better yet, to recast the parameters in such a way that the uncertainties are reduced. For example, a common approach to estimating population involves multiplying site areas by a “typical” population density, as has typically been done in Near Eastern archaeology (Adams 1981; Johnson 1987; Wright 2001). However, in many parts of the world, sites vary in size by several orders of magnitude, and it would seem unlikely that the same population density should be applied to, say, an early urban center as well as a small farming hamlet. In modern settlements, for example, population density scales in a fairly predictable way with population size such that there is no typical population density that applies across all settlements (Bettencourt et al. 2007; Bettencourt et al. 2010). This appears to be true of ancient settlement systems as well (Ortman et al. 2014), so any attempt at calculating a

typical population density, even using a robust calibration data set, will lead to a parameter with a large standard deviation. The solution in this case is to analyze the relationship between population and site area using calibration data, as opposed to a single typical value that applies across scales, and then use the resulting transfer function to estimate population from site areas. The standard error associated with such a function would necessarily be much smaller than the standard deviation associated with a “typical” estimate.

Of course, the most fundamental problem with all population estimates is that they attempt to estimate the resident populations of settlements and regions when, in fact, we have no way of actually taking a census of the residents. As a result, improving methods for estimating population also requires work on the relationship between people and things in contemporary systems or in past systems for which census records are also available. Notable studies in this area include Raoul Naroll’s cross-cultural work on roofed area per person in vernacular architecture (see Brown 1987), Karen Dohm’s research on historic Pueblo settlements (Dohm 1990), William T. Sanders’s work with sixteenth-century Spanish records in central Mexico (Sanders et al. 1979), and Carol Kramer’s work with traditional Near Eastern settlements (Kramer 1982). Whether the results of such studies apply to ancient settlements is open to evaluation, but such studies will remain critical for the foreseeable future.

SUMMARY

I have shown that actual population numbers are essential if one wishes to make progress in a wide range of contemporary archaeological problems, including migration studies, human-environment interactions, and comparative research on scale and complexity. I have also suggested four areas that deserve close attention if we wish to improve upon existing methods and results. These are (1) treating archaeological assemblages as accumulations; (2) seeking out calibration data for all parameters involved in estimating population; (3) developing finer-grained chronological divisions of the archaeological record, especially those that can be applied on surface survey; and (4) developing new ways of quantifying the accuracy and precision of parameters associated with population estimates and the resulting estimates themselves. Given the clear advantages that solid population estimates offer for such a wide range of topics, I think it is more important than ever for investigators to include new methodological research along these lines in their research designs. Significant improvements remain possible only if researchers include relevant data collection and methodological development in their proposals for new work. I hope this chapter will encourage at least a few to do so.

ACKNOWLEDGMENTS

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Quantifying Morbidity in Prehispanic Southwestern Villages

ANN L. W. STODDER

Bioarchaeology contributes many layers of insight into the lives of prehistoric people in the Southwest. Pan-regional studies using metadata from paleodemography and paleoepidemiology show a reasonably good fit between fluctuations in health and what Linda S. Cordell and George G. Gumerman called the “hinge points” in southwestern prehistory (Cordell and Gumerman 1989; see also Nelson, Martin, et al. 1994; Stodder 2005, 2006). However, these studies obscure considerable variation and local trends, revealing little about life in particular communities or at particular times in the past. Population-level data do not always serve themes in contemporary bioarchaeology, which seek to relate social identity and social differentiation to the skeletal manifestation of each individual’s life history. An explicitly multiscalar framework is needed to interpret the variations in health and demography that change population numbers and locations. Life tables and archaeologically derived population estimates are important tools in the study of ancient demography, but, as alluded to in Jeremy Kulisheck’s introduction to this section, life tables are subject to several limitations, especially when used to interpret small populations and incomplete burial assemblages derived from multiple generations of unstable populations. The intent of this study is to introduce another tool for explicating individual life histories in social and political contexts and understanding the underlying dimensions of population health that impact community resilience and vulnerability. As demonstrated in the case studies here, mean age at death and related life table–derived statistics are subject to equifinality; similar statistics can

mask significant variation in community health and lead us to ignore the explanatory potential of the rest of the bioarchaeological record.

The social and economic costs of poor health and suffering from nonfatal conditions comprise a substantial portion of the burden of human disease and are crucial aspects of quality of life in any community. It is these conditions (not acute infections that are the proximate causes of many deaths) that are most reliably recorded in the skeleton, and published or unpublished paleopathology records hold a wealth of underutilized information. In this study I explore the use of disability weighting metrics employed in the World Health Organization's Global Burden of Disease (GBD) program as a tool for comprehending the functional implications of ill health documented in the bioarchaeological record and for framing the impacts of these conditions in a quantitative manner that facilitates comparison of the functional health of individuals and groups within and between communities.

Far from being peripheral to paleodemography, ill health and morbidity—and their underlying social and political causes—are critical factors that drive mortality, differential survival, and fertility both within and across human generations. The functionality and daily well-being of people in the past may seem quite far removed from the “grand challenges” that are identified as critical trajectories of archaeological research (Kintigh et al. 2014), but these were never abstract issues to the people who built and departed from the communities we study. The lived experiences of individuals and groups are driven by and create the very processes archaeologists seek to understand: the origins and consequences of social inequality and political complexity, the motivations for and impacts of migration, short- and long-term changes in fertility and mortality, community resilience, and frailty. Bioarchaeological data sets are multiscalar—built with observations from the bone, to the body, to the population—and our understanding of past peoples is substantially enriched when we engage with these different scales of data in conjunction with paleodemographic data.

I begin this chapter with a summary of the recent trends in southwestern bioarchaeology and paleopathology that lead me to suggest what might seem like an old-fashioned approach to skeletal data, and I introduce the basic tenets of the GBD project and the disability weights. I demonstrate the application of this approach for exploring gendered dimensions of health at San Cristobal Pueblo, a late prehistoric community in the Galisteo Basin. Comparing the San Cristobal metrics with disability weights from the early Pueblo I (PI) communities of the Ridges Basin near Durango, Colorado, illuminates significant differences between the Pueblo IV (PIV) and PI people, and some striking similarities as well.

PALEOPATHOLOGY AND BIOARCHAEOLOGY

Development of the field of bioarchaeology in the United States has largely followed the processualist functionalist trajectory aimed at addressing large-scale questions about the biocultural history of our species, like the consequences of agricultural intensification (e.g., Cohen and Armelagos 1984; Cohen and Crane-Kramer 2007). In the 1980s, the use of nonspecific stress indicators like periostitis and enamel hypoplasias and recording element-specific bony changes became standard practice in systematic analysis of skeletal remains, as eventually codified in *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). The resulting large data sets enabled the transition from the descriptive, anecdotal case study approach to paleopathology as traditionally practiced by physicians and medical historians to an analytical paradigm based on quantitative comparisons. Some of these data consist of frequencies and distributions of *skeletal lesion types* like periosteal inflammation and localized resorptive lesions. Useful as these are for capturing abnormal conditions of bone throughout the skeleton, many of these data points do not correspond to a particular disease or condition with clinically documented symptoms (Cook and Powell 2006, Powell and Cook 2012; Weston 2012).

The difference between considering nonspecific lesion type frequencies and the symptomatic experience of injury and impairment in assessing the health of prehistoric people is a significant one. Much of the paleopathology information recorded over the past century consists of observations of conditions that are present in one or a few individuals, and these data are not easily grouped or incorporated into quantitative population-level analysis. Many skeletal pathologies are reported only—if at all—in the appendix tables of project reports, and the information does not appear in mainstream professional or academic publications (Stodder 2008, 2012). Significant studies by physicians, like James S. Miles's monograph *Orthopedic Problems of the Wetherill Mesa Populations*, have been neglected as sources of expert opinion (Miles 1975). In short, a substantial proportion of the recorded skeletal pathology is not considered when we think about the overall health of communities, how long people lived in one place, and the motivations for migration. Bioarchaeologists have spent a lot of time quantifying lesion types and comparing prevalence statistics of indicators of generalized physiological stress and considerably less time in examining the evidence for and social implications of illness, morbidity, and disability.

The current trends toward more socially and politically contextualized analyses of differential health in skeletal assemblages (e.g., Agarwal and Glencross 2011; Klaus 2012; Martin et al. 2013) and a return to interest in osteobiographies that highlight the lived experience of individuals (Gilchrist 2000; Stodder and Palkovich 2012) accommodate closer study of the kinds of ill health and inequality that impact

the daily lives of people—and ultimately, perhaps, the longevity of communities. Elucidation of the neurological, behavioral, and social sequelae of nonlethal cranial trauma in a group of women (possibly slaves or captives) in the La Plata Valley PII-III sites (Martin 1997, 2008; Martin and Akins 2001; Martin et al. 2008) reminds us that cranial injuries have long-term consequences, as evident in the travails of football and hockey players who suffered multiple concussions years ago. A cluster of children and adults with rickets (bone deformity resulting from Vitamin D deficiency) buried in Plaza G at Arroyo Hondo also points to a particular disadvantaged subpopulation in an Ancestral Puebloan community. Ann M. Palkovich (2008, 2012) suggests that these may have been later arrivals to the town, with access only to poorer quality agricultural land or other lower-quality resources, who thus dwelt in a cycle of ill health and undernutrition that had lifelong impacts on this segment of the Arroyo Hondo community. Moderate disability in adults with residual rickets is one expression of these possible impacts. For at least two generations, one group of people who lived in and around Plaza G at Arroyo Hondo experienced social and economic disadvantages, the physical results of which impacted their ability to lead fully functional lives every day—for years. These studies demonstrate the importance and promise of understanding the social significance of health differentials and the impact of nonfatal conditions on the lives of individuals and communities. We can move closer to understanding the health dimensions of the lived experience if we incorporate the *nonsystematic* paleopathology data (which are often blatantly dismissed as irrelevant even by some bioarchaeologists) and consider the impact of the clinical symptoms those pathologies represent; not just their contribution to mortality statistics, but their consequences for daily life.

GLOBAL BURDEN OF DISEASE

The Global Burden of Disease is a massive multi-decade project initiated by the World Health Organization and the World Bank (with ongoing revisions funded by the Gates Foundation) to quantify the impacts of different diseases, injuries, and risk factors on population health around the world. The overall burden of disease is reported using the disability-adjusted life year (DALYs), a time-based measure that combines projections of years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health (World Health Organization 2014; Lopez et al. 2006). The project defines health as the absence of illness or impairments or functional limitations due to previous illness or injury and disability as the departure from good health in terms of functionality in any of the important domains of health. The GBD identifies eight core domains of health: mobility, self-care, pain, cognition, interpersonal activities, vision, sleep, and affect.

The emphasis on impaired functioning in the physical, social, and emotional realms of life is nicely suited to current trends in bioarchaeology.

On the global scale, GBD metrics are typically reported as disability-adjusted life years. DALY calculations have three main components: (1) DWs—disability weights for particular conditions (as listed in the International Classification of Diseases) and their sequelae; (2) YLDs—years lived with disability; and (3) YLLs—years of life lost due to premature mortality. In bioarchaeology we cannot generate exactly this same kind of data without implementing a series of torturous and ill-advised estimates of how long an individual had been affected by a condition and how long they would have lived without it. The GBD metrics that we *can* use in paleopathology are (1) DWs and (2) prevalence-based YLDs. Prevalence data—the snapshot approach to the number of individuals with a condition at a given time—can be estimated in skeletal remains but not incidence, which is the number of new cases in a given period of time.

Of course, bioarchaeological data sets are rarely, if ever, a representational population snapshot in the same sense as cross-sectional prevalence data sets crafted for epidemiological studies; archaeological mortuary assemblages accumulate over time and include two or several generations. But the DW and YLD framework provides a means to quantify—to *make data out of*—a considerable body of paleopathology observations that are typically excluded from populational data, their impact on peoples' lives largely unrecognized. In this first exploration of the use of GBD metrics, I use paleopathology observations from my research on the protohistoric Puebloans who lived at San Cristobal (LA80) and skeletal pathologies in the early PI people of the Ridges Basin recorded during the Animas La Plata Project (Stodder, Mowrer, Osterholtz, and Salisbury 2010).

DISABILITY WEIGHTS AND PALEOPATHOLOGY

There are a number of challenges in using the DW and YLD metrics with paleopathology data. Some skeletal pathologies that are reported regularly in southwestern bioarchaeology—like cribra orbitalia, scurvy, rickets, and treponemal infection—are not singled out in the list of conditions reported in the GBD literature. And many conditions that are leading components of the global disease burden today (HIV, heart disease, motor vehicle accidents) do not apply to the ancient world or cannot be observed in skeletal remains. However, DWs from a conservatively chosen subset of the conditions in the GBD operations manual (Harvard University et al. 2009) can be applied. Disability weights range between 0 and 1, with higher numbers assigned to conditions with more severe and longer-lasting impacts on individual function. Some DWs are the same for all age groups; others change over

TABLE 8.1. Global Burden of Disease disability weights for some conditions reported in prehispanic Southwest skeletal assemblages

<i>Condition</i>	<i>Disability weight: 15–44-year-olds</i>	
Cataracts/blindness		0.600
Skull fracture		0.411
Lameness		0.369
Intracranial injury		0.359
Femur fracture		0.272
Patella, tibia, fibula fracture		0.271
Vertebra fracture		0.266
Pelvis fracture		0.247
Facial bone fracture		0.223
Deafness		0.216
Rib, sternum fracture		0.199
Ankle fracture		0.196
Radius, ulna fracture		0.180
Osteoarthritis eburnation hip		0.156
Osteoarthritis eburnation knee		0.156
Clavicle, scapula, humerus fracture		0.137
Hand bone fracture		0.100
Cancer, lymphoma, multiple myeloma		0.089
Caries		0.081
Foot bone fracture		0.077
Shoulder, elbow, hip dislocation		0.074
Edentulism		0.061
Otitis media		0.023
Periodontal disease		0.001
Tuberculosis	0–14 yrs	0.294
	15–44 yrs	0.264
	45+ yrs	0.274

Source: Global Burden of Disease Operations Manual 2009

the life course, between infants and the elderly. The GBD data are classified into age groups that are considerably broader and extend further into old age than the age groups used in bioarchaeology. And there is the challenge of generating reliable prevalence data, which requires careful assessment of every individual in each

assemblage as observable or not for each specific condition, based on skeletal completeness and preservation. Furthermore, the skeletal expressions of many pathologies are age dependent, which means there may be an entirely different set of criteria for observability and presence or absence of a condition in infants, children, and adults. Given these issues, the present study is limited to adults—individuals who died at age fifteen and older.

Table 8.1 lists DWs for several conditions reported in skeletal remains from archaeological sites in the northern Southwest. They range from 0.600 for blindness and 0.411 for skull fracture to 0.023 for otitis media (ear infection) and 0.001 for episodes of periodontal disease. The DWs for tuberculosis (TB) in children under fifteen, in adults up to age forty-five, and in individuals older than age forty-five are listed in the table (an exception to the focus on adults), because TB is one of the most—if not *the* most—significant communicable diseases prehistorically present in the region. Cancers are occasionally reported in southwestern skeletal assemblages (Akins 2010; Hanson et al. 1999; Martin et al. 2001). Recent documentation of several cases of multiple myeloma (assigned a DW of 0.089 for preterminal cases and 0.809 for terminal cases) in individuals from the Taos area (Whitley 2009; Whitley and Boyer 2012) suggests that environmental cancers from prolonged, multiple pathway exposure to radiogenic isotopes was a serious health threat in some regions.

In addition to skeletal evidence for morbidity, coprolite studies document parasitism as a significant health problem in several prehistoric communities, including Antelope House, Aztec, Salmon Pueblo, and Pueblo Bonito (Dittmar et al. 2012; Reinhard 2008; Reinhard and Bryant 2008). Two of the conditions—trichuriasis (whipworm) and ancylostomiasis (hookworm)—and their sequelae are assigned DWs by the GBD, listed for age groups in table 8.2. While not as common as giardiasis and other infestations, the significance of anemia and cognitive impairment (in contrast to the contemporaneous cognitive deficit) caused by these conditions should remind us that parasitism, especially if it is widespread and seasonally recurring, constituted a very real source of morbidity (and mortality for the most vulnerable).

YLDs: YEARS LIVED WITH DISABILITY AT SAN CRISTOBAL PUEBLO

In this pilot study I added GBD age classifications to the San Cristobal paleopathology catalog and tabulated the observability, presence, and absence of sixteen conditions in the 172 adults. The DWs are multiplied by the prevalence of the condition to generate YLD values—the years lived with disability (caused by that condition) for every 100 individuals. San Cristobal was occupied from the early 1300s to around the time of the Pueblo Revolt in 1680. Nels C. Nelson (1914, 1916)

TABLE 8.2. Disability weights for parasitism sequelae at Antelope House, Aztec, Salmon Pueblo, Pueblo Bonito

<i>Condition</i>	<i>Sequelae</i>	<i>Age</i>				
		<i>0–4</i>	<i>5–14</i>	<i>15–44</i>	<i>45–59</i>	<i>60+</i>
Trichuriasis	Contemporaneous cognitive deficit	0.006	0.006	0.006	0.006	0.006
	Massive dysentery syndrome	0.138	0.116	0.114	0.114	0.129
	Cognitive impairment	0.024	0.024	0.024	0.024	0.024
Ancylostomiasis	Anemia	0.024	0.024	0.024	0.024	0.024
	Cognitive impairment	0.024	0.024	0.024	0.024	0.024

Sources: Reinhard 2008; Reinhard and Bryant 2008

excavated the site, and, later, Louis Sullivan excavated additional burials from the middens. Most of the burials cannot be securely dated to pre- or postcontact, but Nelson’s field notes indicate some areas of the site as older and certain structures as postcontact (Stodder 1990).

The condition with the highest YLD in the San Cristobal adults (figure 8.1) is lameness—which encompasses limitation of hip, leg, or foot mobility—resulting from different kinds of injuries and their long-term sequelae, including advanced joint degeneration, dislocations, fractures, and other conditions that would fall into the circular file category of “isolated cases” of pathologies, including acromegaly and talocalcaneal coalition. Acromegaly—present in an adult female from San Cristobal (Stodder 1990) and also reported in an individual from Pottery Mound (Rhine 1985)—develops after completion of normal growth, as a pituitary tumor prolongs secretion of growth hormones. The array of symptoms—including headaches, joint and back pain, enlarged hands and feet, altered facial features, defective vision, hypertension, infertility, sleep apnea, and fatigue—increasingly impairs functioning in practically every realm of life for many years, leading to serious health problems and, ultimately, premature death (Novartis Pharmaceuticals Corporation 2011). Skeletal changes are widespread and particularly marked in the facial bones (Ortner 2003). While clearly impacting gait, there is no single disability weight that would apply to the many symptoms associated with acromegaly (and this suggests that it might be worthwhile in future work to generate summary YLD values for each individual). Talocalcaneal coalition—the fusion of the calcaneus and talus—becomes symptomatic starting in the teenage years. Deep pain and limited mobility of the ankle and foot eventually alter gait and muscle attachments. This autosomal dominant condition is present in two men from San Cristobal—brothers or perhaps a father and son.

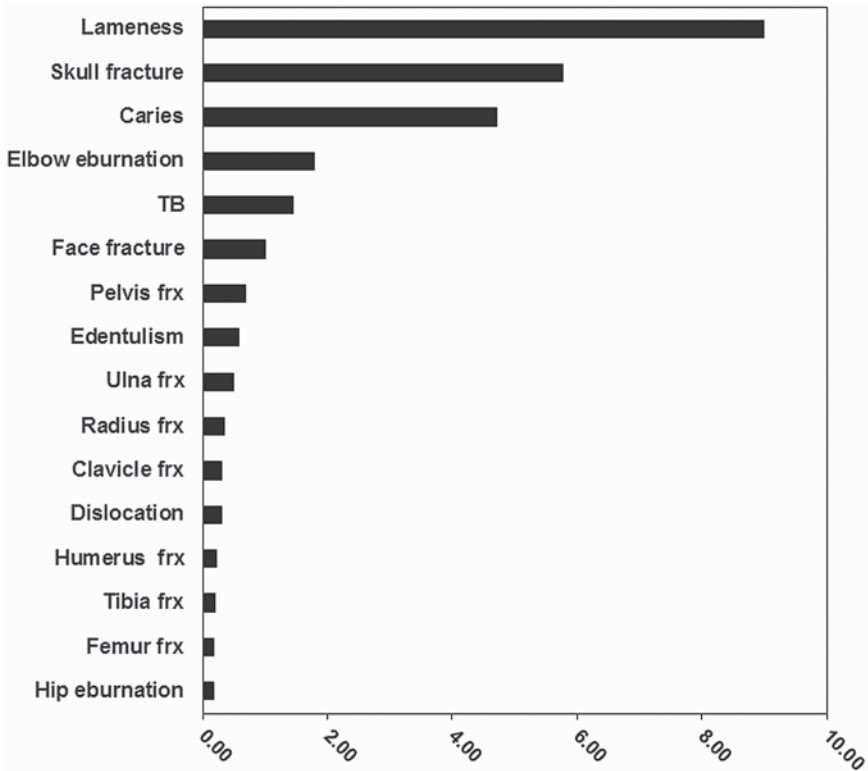


FIGURE 8.1. YLDs (years lived with disability per one hundred individuals), San Cristobal adults.

Lameness is certainly not a condition typically reported in osteological reports, and it is a perfect example of the “symptom” approach (versus the “lesion type” approach) in capturing a very common disability with numerous causes. The disabilities experienced by men whose walking is impaired by deep pain (starting at age thirteen) and by a woman with dizziness, headaches, joint pain, and infertility (beginning in early adulthood) have both economic and social impacts.

The second highest YLD value among San Cristobal adults is for skull fractures; third is caries. The fourth highest disability cause is elbow eburnation. Eburnation—polishing on the bony surface of a joint, indicating complete destruction of the cartilage—is used here as the indicator of advanced osteoarthritis because this is one bony symptom of osteoarthritis that is known to consistently correlate with clinical symptoms (pain); whereas some of the bony changes that we record in the development of osteoarthritis do not, or do not consistently, have associated clinical

symptoms (Waldron 2012). The elbow eburnation YLD score in San Cristobal females is nearly five times higher than the YLD in males—3.26 versus 0.71.

Tuberculosis is fifth in the YLD rankings. Only 3 to 5 percent of people with pulmonary TB also have skeletal lesions (Roberts and Buikstra 2003:89), so the identification of eight individuals (including children) with skeletal TB suggests that as many as twenty-four to forty people at San Cristobal had the disease—perhaps as many as 3 percent of the late population of the site, estimated at around 1,300 people (Stodder 1990). This might be a high or low estimate, but TB is a highly contagious disease that is well known to flourish in times of warfare and demographic disruption and in communities crowded with people experiencing a range of immunological compromise, including poverty and undernutrition. The eight individuals with TB were buried in Middens D and E, in the northern part of the site believed to date to the last years of occupation, just prior to the Pueblo Revolt. The Spanish colonial presence brought epidemics of measles and smallpox and stressed the indigenous economic system in an era of drought cycles (Simmons 1979; Stodder 1990, 1996). Symptoms of TB include bone and joint pain, back pain, localized swelling, muscle weakness, wasting, draining sinuses, cough, fever, spinal cord compression, numbness in lower limbs, incontinence, and paraplegia (Roberts and Buikstra 2003:95–96; Roberts and Manchester 2005:192). The adult YLD for TB at San Cristobal is 1.44, but including the subadults, we can estimate almost twelve years lived with disability from this disease for every 100 people in the community.

Returning our focus to the adults, the sum of YLDs of the twenty-five conditions listed in table 8.1 is 27.27. The sum of YLDs in males and females is 25.52 and 29.48, respectively. Females have a higher burden of disability from several conditions (figure 8.2), including impaired mobility, TB, advanced arthritis in the elbow and hip, and humerus and clavicle fractures. The striking difference in elbow eburnation YLD between women and men echoes the repeated findings of significant upper arm strength and stress in Ancestral Puebloan women demonstrated through analysis of musculoskeletal stress markers, robusticity, and cross-sectional geometry (Ogilvie and Hilton 2011; Perry 2004, 2008) and attributed to grinding corn, starting at a young age, for domestic use and, increasingly, for ceremonial community purposes (Crown 2000; Perry 2008; Spielmann 1995). Males have a higher burden of disability resulting from pelvis fractures but also skull and face fractures, the notably high rate of which correlates with unrest in the region prior to and especially after the presence of Europeans. The YLD figures point to some readily interpretable differences in the health burdens of men and women in this community and some more subtle distinctions that suggest other avenues of interpretation and closer scrutiny.

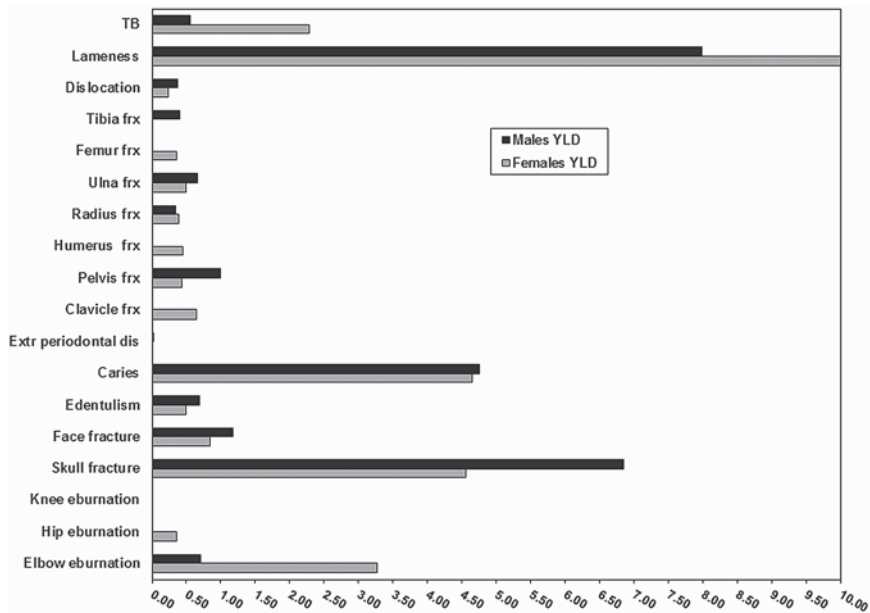


FIGURE 8.2. YLDs, San Cristobal males and females.

COMPARING MORBIDITY: RIDGES BASIN PUEBLO I AND SAN CRISTOBAL PUEBLO IV

Prevalence and YLD data for the same sixteen conditions in 167 adults from contemporaneous early PI village sites in the Ridges Basin of southwestern Colorado are shown in figure 8.3. The Ridges Basin paleopathology data were generated during the Animas-La Plata Archaeological Project (administered by the Ute Mountain Ute Tribe under an agreement with the US Bureau of Reclamation) by osteologists employed by SWCA Environmental Consultants: Elizabeth Perry, Kathy Mowrer, Erin Salisbury, and Anna Osterholtz (Stodder, Mowrer, Osterholtz, and Salisbury 2010).

Skull fractures imposed the highest disability burden in these small villages. Lameness, caries, and advanced degeneration of the knee joint rank second, third, and fourth, respectively, in disability burden. Some of the other conditions observed in the Ridges Basin PI people include congenital deafness, which has a DW of 0.233 for infants and 0.216 for adults under age 45; dislocations of the hip and shoulder (DW 0.74); neurofibromatosis, which probably resulted in blindness (DW 0.600); and vertebral fractures (DW 0.266).

Use of the San Cristobal and Ridges Basin assemblages for this study reflect my access to laboratory records and illustrations rather than a specific research design.

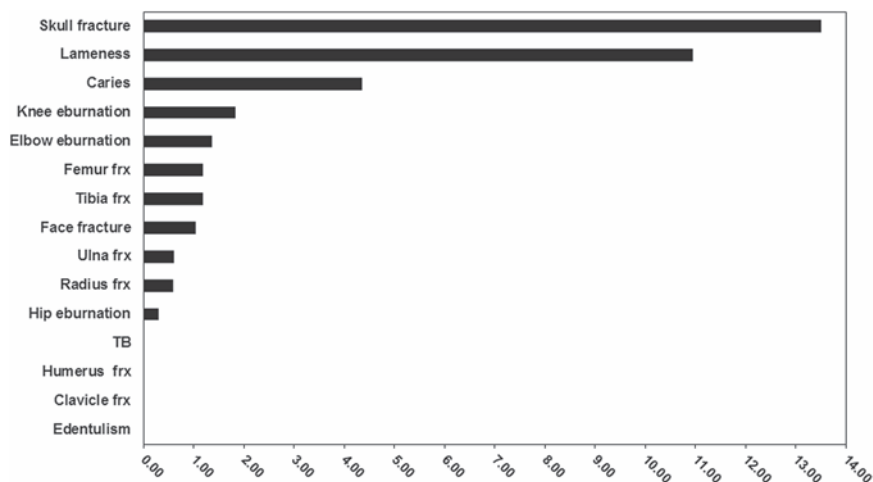


FIGURE 8.3. YLDs, Ridges Basin adults.

These two groups of people, separated by at least six centuries, lived in some of the earliest and latest villages in Puebloan prehistory. Yet the same three conditions yield the highest YLDs in both assemblages: skull fractures, lameness, and caries. As evident in comparing the YLDs (figure 8.4), no individuals in the Ridges Basin assemblage exhibited TB or humerus or clavicle fractures, and none died completely edentulous (toothless). Knee eburnation affected people in this rugged landscape, and fractures in the tibia and femur comprise a substantial portion of the Ridges Basin total YLD of 36.87, which is strikingly higher than the 27.27 YLD total for San Cristobal. There is more evidence of traumatic injuries to the infracranial skeleton and skull fractures in the Ridges Basin assemblage. Facial fractures—which are typically interpreted as the most personal of interpersonal violence—have the same burden in the PI and PIV groups. Puebloan occupation of the Ridges Basin ended shortly after the massacre of more than thirty individuals whose processed remains were deposited in a pithouse at Sacred Ridge (Chuiпка 2009; Stodder, Mowrer, Osterholtz, and Chuiпка 2010). The processed human remains are not included in the YLD analysis, but the partially reconstructed skulls from this assemblage reveal ample evidence of antemortem cranial trauma (Stodder, Mowrer, Osterholtz, and Salisbury 2010). The people buried at San Cristobal Pueblo lived in turbulent times to be sure, but the YLD framework shows us that, in addition to leading physically demanding lives resulting in functional impairment for many individuals, people in Ridges Basin who lived in the earliest aggregated villages participated in or were at least exposed to substantial social conflict.

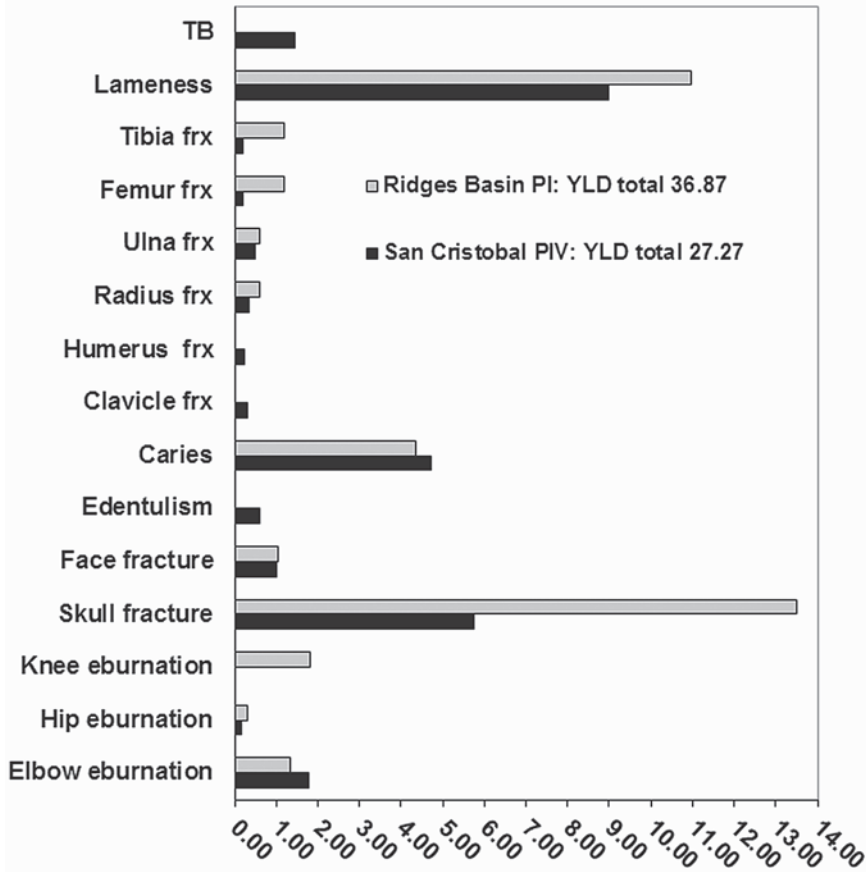


FIGURE 8.4. YLDs, San Cristobal and Ridges Basin.

Given the marked differences in adult disability burdens—36.87 for Ridges Basin and 27.27 for San Cristobal—it is particularly interesting that the life tables for these two assemblages yield the same mean age at death: twenty-two years (Stodder 1990:103; Stodder 2010:70). This is a very clear sign that the YLD data have much to tell us about quality of life and the nature of morbidity and disability that is not reflected in the statistical abstractions used in paleodemographic analysis. Disabilities of many kinds affect individual functioning in social, physical, and emotional realms of life and can have profound implications for the viability of small communities. In this preliminary application of GBD metrics, it is evident that different burdens of disability are related to landscape and subsistence activities, gendered division of labor, infectious disease, genetic load, and

social violence and that disease burden differences are not reflected in standard demographic indicators.

CONCLUSION AND PROSPECTS

The YLD framework is not meant to replace paleodemography, the paleoepidemiological profile based on nonspecific stress indicators, or population prevalence data for skeletal pathologies. Instead, this approach complements other data and adds an intuitively meaningful dimension, moving us toward an experiential approach to life in prehistoric communities. This preliminary study compares disability burdens in males and females at San Cristobal and explores similarities and contrasts in ill health and impairment in early and late prehistoric Ancestral Puebloan communities. Comparing disability burdens of adults in particular pre- and post-migration communities may reveal thresholds of morbidity in one or more segments of the population in donor communities and the extent to which health was better in post-migration contexts.

Michelle Hegmon and colleagues seek to rank physical suffering as a part of social transformations in the prehistoric Southwest, and the disability weight approach suggests a useful tool for this endeavor (Hegmon et al. 2008:315). A YLD approach is well suited to studies of community resilience and vulnerability (e.g., Hegmon et al. 2008; Nelson et al. 2010) that examine multiple factors and trade-offs in community adaptation at local and regional scales. For example, exploration of adult morbidity and disease burden in a variety of Pre-Classic and Classic Hohokam communities could provide new insights into the variable dimensions of subsistence stress and health in centrally and peripherally located residential groups in the Salt-Gila region (Hill and Lincoln-Babb 2008; Meegan 2009; Rodrigues and Loendorf 2008). Such an approach could considerably augment (and perhaps alter) explanations of the Hohokam demographic decline, which is currently based on indicators of nonspecific stress and nutritional status in children from inhumations at Pueblo Grande (Meegan 2009; Sheridan 2003; Van Gerven and Sheridan 1994).

More skeletal conditions can be incorporated into the DW/YLD framework, and we could generate summary YLD scores for individuals, affording an even finer-grained picture of health differentials within communities. I do not think we can generate disability-adjusted life year data using skeletal remains, but there may be useful real-world data in some of the GBD regional projects that use prevalence-based YLD. The GDB metrics are not applied to subadult pathologies here, but we have abundant data on childhood conditions like enamel hypoplasia and cribra orbitalia and a growing record of rickets and scurvy. It is the disability component of suboptimal health in adults that is often lost in site specific and regional studies.

Disability is a socially constructed category, like race and gender (Cross 2007), and as archaeologists we cannot know what degree or kinds of social stigma may have been associated with the kinds of physical impairments revealed in skeletal remains. While we assume that functional impairment has negative consequences for individuals and their community because of the economic ramifications, attitudes toward blindness, deafness, and even diseases like tuberculosis are certainly not universal (Roberts 2000, 2011). The assignment of disability weights to conditions and their sequelae is an interesting issue within the GBD project. Not surprisingly, people in cities in the Netherlands assign different weights to many conditions than people using rural health clinics in Zimbabwe (Jelsma et al. 2000; Salomon 2010). Disability studies are relatively new in archaeology and not without controversy, but the study of physical impairment, morbidity, and disability by symptom, rather than by etiological category or isolated bits of medical history, suggests a promising avenue for explaining the demographic and social consequences of ill health in the past.

Demographic Patterns in the Prehispanic Puebloan Southwest

The Role of Childhood

KATHRYN A. KAMP

As Jeremy Kulisheck (this volume) points out, understanding demographic patterns requires a nuanced consideration of the dynamic interrelationships between social and ecological conditions and the size, composition, and health of subgroups comprising the population under consideration. The proportion of children, a critical element of the demographic structure of any society, is a function of age-dependent mortality rates and the fertility rate. Fertility—the actual number of children born to a woman over her lifetime—depends on fecundity (defined as reproductive potential) and cultural ideas and practices that determine the extent to which full reproductive potential is achieved. Although fecundity is a biological concept, it responds to factors such as food shortages, which are the consequence of both environmental and cultural processes. Models of prehistoric population fluctuations due to *in situ* population increases—not immigration—have often treated changes in fertility as fairly automatic biological responses to cultural changes rather than wholly or partially due to cultural choices informed by the desire for a particular demographic structure. I argue here that agency should also be discussed as a factor that may have helped determine the number of children borne by women in the past, just as we view choice as one factor when discussing reproductive patterns of the present. I propose a model that includes decision-making based on evaluations of the perceived benefits of children, their costs, and the risks associated with successfully bringing a child to adulthood. Thus, the desired proportion of children and, perhaps, even the desired gender balance is partially the result of a

costs-benefits analysis. The actual reproductive decision-making takes into account both the final reproductive goals and the perceived risks to offspring.

In the prehispanic Puebloan Southwest, fertility was generally high and a trend toward regional population growth related to maize agriculture has been proposed (Kohler et al. 2008). The basic outline of this scenario suggests that, through time, agriculture became more important and lifestyles more sedentary. These changes co-occurred with technological innovations (e.g., the introduction of ceramics) and social ones (e.g., increased social stratification). The model posits that more readily available infant foods, such as cornmeal, reduced the duration of breastfeeding. Lactation induces temporary infecundity (Bongaarts 1978; Wood 1990), making variation in fertility an intended or unintended outcome of differential norms for breastfeeding. The biological mechanism involves elevation of the levels of prolactin, which interferes with the hypothalamic-pituitary-ovarian axis and prevents the estrogen secretion necessary for ovulation. The effect of lactation is diminished if supplemental foods are used or the intervals between feedings are greater than four hours during the day and six hours at night (King 2007). Simultaneous with the introduction of potential supplementary infant foods, more sedentary lifestyles would have decreased the need for the extensive carrying of infants and young children. The physical effort entailed in adding a child to other loads, especially in conjunction with breastfeeding, might have acted to keep the weights of many postpartum women low. When the body weight index is too low, the pituitary gland can fail to produce luteinizing hormone and follicle-stimulating hormone, causing amenorrhea (Hamilton-Fairley and Taylor 2003). Thus, the argument runs, an increased reliance on domesticated plants, combined with more sedentary lifestyles, would have caused birth intervals to increase strictly for biological reasons, without any human intent. Although this model is attractive and probably correct in part, it does not explain the extreme regional variation in demographic distributions, as determined by the proportion of infants and children found in mortuary contexts (Kohler et al. 2008; Sobolik 2002), nor does it grant sufficient agency to past individuals.

In contrast, the model I propose emphasizes costs-benefits and risk management as the primary drivers for fertility; it has the potential for explaining both the generally high fertility and the observed variability. The model assumes that the portion of children in the population and the ensuing population growth that accrues due to increased fertility, as opposed to migration, is a result of an interrelated web of biological and cultural factors, only some of which directly relate to subsistence. A woman's fertility is partially dependent upon decisions about whether and when procreation is desirable. The details of family dynamics, including kinship patterns, age at marriage, the kinds of roles undertaken by children, as well as the social and

environmental stresses to which individuals are subjected, may be as important as subsistence strategies. At the core is the balance between the desirability of children, the costs of raising them, and the uncertainties associated with the successfully bringing children to adulthood. Increases in the benefits of children relative to their costs, in the perceived risks to children, or a combination of the two may lead to a desire for larger numbers of children and, consequently, to increases in fertility.

This chapter should be viewed as a preliminary exploration of some of the evidence required to apply the model to prehispanic Ancestral Pueblos. After a brief description of the basic demographic patterns, I first explore the costs and benefits of bearing and raising children and then some of the risks to child survival. While I focus here on prehispanic Pueblos, I rely extensively on cross-cultural comparative materials from modern ethnographic and demographic studies as scaffolding for a general analytic model of a costs-benefits/risks of fertility patterns.

THE PROPORTION OF CHILDREN IN THE PREHISPANIC SOUTHWEST

Mortuary contexts from prehispanic Puebloan sites are generally characterized by high percentages of subadults (see Kohler et al. 2008 and Sobolik 2002 for overviews). Jean-Pierre Bocquet-Appel and Stephan Naji demonstrate that the shape of the population pyramid has a greater impact on the age distribution of graves in burial assemblages than do mortality rates (Bocquet-Appel and Naji 2006). Thus, the proportion of young in a burial assemblage directly reflects the proportion of children in the population and is an indirect measure of fertility. While the construction of models requires the assumption that the data being used are valid, intersite comparisons can be difficult because the burial assemblage is also affected by factors such as the differential preservation of adult and subadult skeletal elements and the interaction between archaeological excavation strategies and cultural burial practices, which may result in under- or overrepresentation of certain age groups (Stodder 2010).

The most extensive analysis of prehispanic southwestern fertility to date (Kohler et al. 2008) finds considerable variability over time and between regions. That study uses a method developed by Bocquet-Appel (2002) that examines the proportion of individuals between five and nineteen years old to provide an index of population growth due to variation in fertility. Their findings mirror the conclusions of Kristin D. Sobolik (2002), who shows that, while the overall proportion of subadult burials in southwestern sites is high—averaging 42 percent—there are extreme divergences from this mean. Some of the variation is doubtless due to simple sampling error. Since the effect of sampling error should be less in large samples, it seems logical to disregard small assemblages. Even restricting the

corpus of sites to those with 100 burials or more, the variation in the proportion of subadults is clear. For example, some of these sites that Sobolik (2002:table 7.2) lists, such as Grasshopper (68 percent), Arroyo Hondo (56 percent), and Gran Quivira (59 percent), have particularly high proportions of subadult burials; others, such as Pecos Pueblo (22 percent) and Point of Pines at AD 1285–1450 (30 percent), have relatively low proportions.

The subadult designation based on physical immaturity that is used by bioarchaeologists does not directly correspond to the sociocultural designation of whom might be referred to as a child. It is now well accepted that, like gender, childhood is a cultural concept (e.g., Ardren 2006; Ardren and Hutson 2006; Baxter 2005, 2006; Kamp 2001b; Kamp 2002b; Neils and Oakley 2003; Sofaer Derevenski 2000). Both local understandings of the nature of children and the actual activities of children and adults vary considerably cross-culturally and can change through time within a single culture, sometimes fairly rapidly. Even the definitions of the age range for the period of childhood and the stages into which it is divided are culturally determined. Nevertheless, the high proportions of subadult burials undoubtedly do reflect large numbers of what would have been culturally defined as children.

Just as childhood is a social construct, so are fertility and parenting. The exact configurations of both fertility and parenting are partly structured by variables such as subsistence systems, the type of household structure, and inheritance patterns (Gupta 1997; Skinner 1997). The analysis of fertility as a social construct is complex, involving not only the parents and their perspectives, but also other social actors who may have a say in procreative decisions. It requires consideration of the ways the economic value of children is perceived in the context of other ecological, psychological, and social values (Townsend 1997). Personal status may depend on demonstrating fecundity and/or assuming parental roles, and both sterility and amenorrhea may be experienced as severe social and personal dilemmas (Handwerker 1986; Inhorn 1996; Monsted and Walji 1978). The meaning of parenthood, actual parenting techniques, the number of children in a household, and decisions about fertility all exhibit considerable cross-cultural variability but are intertwined in complex ways (Kamp 2015). Parenting practices range from extreme parental involvement to strategies that rely primarily on other children or relatives and community members.

AGENCY AND FAMILY PLANNING IN PREMODERN POPULATIONS

There is some controversy among demographers about whether couples in premodern societies with less understanding of the biological principles of conception and less effective birth control methods act to limit fertility and, if they do, the appropriate ways of understanding their motivations (Lee 1977; Lockwood 1998).

There is some support for the idea that premodern people did regulate family size and even gender composition (Carter 1995; Cashdan 1985; Crosbie 1986; Lee 1977; Skinner 1997). Comparative studies show that the gender of existing offspring may influence decisions about the timing of the next pregnancy, as the interval until the birth of the next child may be lengthened or shortened depending upon the sex of the previous child (Carter 1995; Skinner 1997). Peter H. Lindert (1977) convincingly shows that since the Civil War, long before the advent of modern birth control techniques, American couples were regulating their fertility in response to factors such as the work performed by children, the time required to raise a child, and tax incentives. Similarly, a study of fertility in a US Mexican American community in the absence of contraceptive use found that fertility varied according to the extent to which children were able to contribute economically to the household (Whiteford 1986).

Just as individual couples and larger social units today think about children as part of plans for the future, Ancestral Puebloans doubtless thought and talked about the desirability of children, the ideal number of children, and perhaps even the ideal gender composition of a family. They also may have exhibited a level of agency in determining the size of their family by using traditional practices, perhaps including some of those described below. This suggestion is not meant to imply that Ancestral Puebloans had a completely accurate and rational costs-benefits model for determining ideal family size and composition; nor should it suggest that they were able to reliably achieve their family planning goals or even that cultural practices were necessarily consistent with those goals—merely that they had a level of agency within the reproductive process.

DETERMINANTS OF FECUNDITY

Fertility rates are determined by the interaction of cultural and biological factors, so an analysis of fertility demands both an understanding of relative fecundity and its causes as well as the cultural practices and individual decisions that lead to variation in fertility rates. Because parental health influences fecundity, ecological and cultural factors relating to health are critical to an understanding of population dynamics. Factors as diverse as subsistence strategies, warfare, crowding, responses to food shortages, traditional medical knowledge, and bodily modifications are potentially part of the fecundity-fertility equation.

Sterility or temporary amenorrhea due to poor health or nutrition can significantly lower the fecundity of populations (Cohen 1993; Jolly and Gribble 1993; Lockwood 1998; Monsted and Walji 1978). When the health of women of child-bearing age is poor, the percentage of impregnations that result in live births

decreases due to spontaneous abortions and difficulties during pregnancy and birth. The effect of poor health is dramatically illustrated in Africa, where the high incidence of STDs in some areas has resulted in levels of infecundity as great as 20 percent, in contrast with normal rates of around 3 percent (Cohen 1993; Jolly and Gribble 1993; Lockwood 1998). The length of time between menarche and menopause is also at least partially a consequence of health and nutrition (Dahiya and Rath 2010; Lousstaunau and Sobo 1997:61), with subpopulations in the developing world having mean ages at menarche as high as seventeen (Rebacz 2009; Blurton Jones 1993).

It is likely that poor nutrition or disease, particularly during periodic times of stress, lowered fecundity in the Puebloan Southwest, but the effects would have been neither temporally nor spatially uniform. Skeletal remains show health problems associated with anemia, infections, poor dental health, and arthritis (Martin 2000; Palkovich 1980, 1985a; Stodder, this volume; Whittaker et al. 1999). Life expectancy was relatively short, with mean ages at death tending to be in the twenties or late teens (Stodder 2010:73, table 4.4). Furthermore, as Ann L. W. Stodder (this volume) shows, many Pueblo individuals had health problems that would have impaired their quality of life and which sometimes affected fecundity and fertility. Much of the ill health in the prehistoric Puebloan Southwest may have been due to reliance on corn agriculture and the precarious nature of agriculture in the region, although parasites and infectious diseases are also implicated (Holland and O'Brien 1997; Reinhard 1992; Walker 1985). Historic Puebloan groups engaged in dry farming experienced crop failures about every third year (Bradfield 1971:21; Minnis 1985:130). When these failures caused famines, the results may have been disastrous. During famines in India toward the end of the nineteenth century, less than half the births were live (Guz 1989), and the effects persisted during the year following the food shortages as a result of malnutrition and exacerbated health problems.

Iron-deficiency anemia was particularly endemic in the Puebloan Southwest, probably due to reliance on maize as a staple (Walker 1985). Maize is a poor source of iron and may even inhibit its absorption. Archaeologically, anemia is reflected in high rates of porotic hyperostosis and cribra orbitalia. Data on these two conditions are available for only some sites, and the two are not always differentiated, as their etiology is similar (Sobolik 2002). At some Puebloan sites, anemia was recognizable in up to 70 or 80 percent of the population (Akins 2001; Stodder 2006). The effects are particularly noticeable among the very young. Overall, the incidence of iron-deficiency anemia tends to be lower at large sites and in later time periods (Akins 2001; Sobolik 2002). The considerable inter-site variation in skeletal markers of ill health is not easy to interpret, as many of these take time to develop.

Pregnancy and birth, especially, were fraught with danger for both mother and child, primarily due to mothers' health problems (Hinkes 1983). The high costs of childbearing included death in childbirth for the mother, spontaneous abortions, high infant mortality, and low birth weight babies. The stresses of nutrition and disease created an intergenerational spiral such that mothers' poor health resulted in infants with health problems. Some of these problems persisted through childhood and ultimately resulted in mothers who, in turn, had more difficulty giving birth.

In traditional societies, a mother's death in childbirth is not uncommon and may account for up to a third of women's deaths during childbearing years (Hewlett 1991). If the mother perishes in childbirth, the neonate is also in danger, both from complications due to the difficult birth and, if alternatives are not available, the need for a secure milk supply from another nursing woman. Nutritional problems experienced by many Puebloan women increased the probability of death in childbirth. Debra L. Martin (2000:280) has demonstrated that, at Black Mesa, women who died younger tended to have more constricted, flattened birth canals, which might have led to a more difficult and potentially even fatal labor. Such pelvic structures were probably the outcome of nutritional deficiencies during skeletal development.

The increased nutritional demands of both pregnancy and lactation are stressful and may be helped or exacerbated by food prescriptions and/or taboos (Lancy 2008:37; Profet 1992). Because pregnant women have enhanced needs for both calories (15 percent more) and protein (65 percent more), periodic lean years would have put particular stress on women's health (Martin 2000:272; Wetterstrom 1986). Close birth spacing exacerbates these issues and may have led to maternal depletion, an additional cause of increased maternal mortality (Skinner 1997).

It may have been within the ability of Pueblos to counter some of these problems by favoring the nutritional needs of women over those of men, especially during pregnancy, nursing, and in periods of food scarcity. Access to protein, in particular, can now be monitored using isotopic analysis. This analysis has not been systematically undertaken, so the available data do not reveal as much about variability as would be desirable. Nevertheless, it seems to indicate that, particularly during later time periods, women at some sites had less access to meat (Ezzo 1993). A study by Ann L. W. Stodder comparing the health of girls and boys at age three suggests that the preferential treatment of males may have begun in childhood (Martin 2000). So what we know of women's health and their cultural practices suggest that the parenting decisions made during a woman's pregnancy may have exacerbated existing nutritional problems rather than alleviating them. Because the health of women varies from community to community, the impact on fecundity would not have been uniform and is probably one of several factors having an impact on fertility rates.

DETERMINANTS OF FERTILITY

More significant to overall fertility, however, may have been cultural factors such as the average age at which sexual activity begins for women and the nature and frequency of early coitus. Pueblo women, at least at some sites, appear to have begun having children at fairly young ages. During Pueblo II (PII) times, some 30 percent of deaths for women who had reached reproductive age occurred before age twenty, versus less than 10 percent for comparably aged males (Martin 2000). This finding suggests that first births occurred at least by the late teens, but this variable deserves more attention, as the possibility of changes and variation in age at first birth is an important variable for explaining demographic flux. Because an earlier age at first birth shortens the temporal length of a generation, it has a particularly large effect on the rate of population increase, even if average fertility remains the same.

Other cultural practices that affect the probability of conception also have an impact on differential fertility rates. Birth rates and spacing may be regulated by using traditional contraceptive methods, prolonging breastfeeding, practicing abstinence, regulating the frequency of intercourse, terminating childbearing before the end of the reproductive cycle, or with infanticide and selective neglect (Bongaarts 1978; Cashdan 1985; Friedl 1989; Jolly and Gribble 1993; Knodel 1988; Lockwood 1998). Most of these practices are prescribed by culturally recognized rules. Thus, there are usually general notions about the appropriate duration of breastfeeding. Nevertheless, these mores change through time and are susceptible to individual manipulation (Cleveland 1986; Weil 1986). Similarly, sometimes there are ideas about the appropriate ages at which to cease having children. For example, Erika Friedl (1989) notes that Iranian villagers view procreation after one's adult children have begun to do so themselves as unseemly, since pregnancy is an overt acknowledgment of sexual activity. Temporal restrictions on sexual activity often—but not always—may have decreased fertility. Sexual abstinence in religious contexts occurs among modern Puebloan groups (Frigout 1979; Tedlock 1979; Lange 1959; Titiev 1944), although we cannot be certain that continence was characteristic of the pre-hispanic Pueblos as well.

As mentioned previously, lactation suppresses ovulation, so prolonged breastfeeding will tend to result in long birth intervals. Potential reasons for shortening the length of breastfeeding include the availability of suitable food substitutes, the need for the woman's labor, the desire for an additional child (especially in cultures where sexual intercourse is seen as polluting to a nursing infant), stresses on the mother's health, and even the cultural notion that breast milk is deleterious to the health of the infant (Hastrup 1992). For an infant, the advent of a baby will usually mean that the mother stops nursing, and if this happens too soon, the infant may be subjected to nutritional stress. Explicit voice is sometimes given to this fear, as in

Tanzania, where conventional wisdom held that couples should not have an additional child until the infant “has got his health” (Lockwood 1998:68).

In a situation of high infant mortality, one buffer would be to prolong breastfeeding. This choice would, however, be effective only in conjunction with the simultaneous introduction of some solid foods, as older children require nutrients not found in breast milk. Furthermore, the caloric stress on the nursing mother, were she to provide enough nutrients for an older child, would be too debilitating without the use of supplements. We do not know what types of foods were used as supplements, but possibilities include corn gruel, amaranth, or broth; the latter two would have provided a more diverse and protein-rich diet to the developing child. While prolonging breastfeeding would involve some cost to the mother, the most costly stages of pregnancy and birth would have already been traversed, making it worthwhile to continue investment in children who had survived the first stages of infancy. Nevertheless, the overall effect of lactation on infant and child mortality may be even more complex than this discussion suggests. Although lower infant mortality results from prolonged breastfeeding, lower child mortality also occurs when infants are not breastfed, perhaps because they do not get weanling diarrhea (Knodel 1988).

Archaeologically, cessation of breastfeeding is indicated by the location of enamel hypoplasias and by early peaks in morbidity. Evidence from Grasshopper Pueblo suggests weaning ages from two to three. In the Mesa Verde region, health declined between the early period (before AD 975) and the later one (AD 975–1275) (Martin 2000). As noted earlier, at the same time, age at weaning appears to have increased from around two or three to four or five in the Pueblo II-III period. This change in parenting behaviors may represent an attempt by women to counter worsening conditions. Its effect would have been to lengthen the average period to the next conception. Nevertheless, nursing is not an infallible method of birth control. It is possible to bear a child while still nursing the previous one. Thus, the effect of extremely long breastfeeding on birthrates may not have been as dramatic as one might suppose.

An interesting case study of rickets at Arroyo Hondo (Palkovich 2008) suggests the potential problems that may occur if breastfeeding is too prolonged. Ten of fifty-three scorable adults and sixteen of forty-eight scorable subadults had skeletal abnormalities consistent with a diagnosis of rickets. At Arroyo Hondo, rickets appears to be a disease that begins in infancy and childhood. Ann M. Palkovich (2008:145) posits:

Mothers who may also have been Vitamin D deficient may have practiced prolonged breastfeeding or may have fed their infants foods deficient in calcium and/or phos-

phorus. These malnourished infants, also more susceptible to infections including diarrhea and pneumonia, may have been cloistered indoors or completely bundled in clothing, thus severely curtailing natural Vitamin D synthesis from sunlight. The most severely affected infants may have been listless, apathetic and perhaps even experienced seizures.

While most fetal and infant deaths occur as a result of problems with health and nutrition, some deaths result from the decision to terminate a pregnancy. Other infants may perish due to infanticide. William T. Divale and Marvin Harris analyzed a sample of 393 societies and found that 179 (46 percent) “commonly” practiced infanticide, while only 91 (23 percent) “never” practiced it (Divale and Harris 1976). Infanticide often occurs immediately after birth, before the neonate has acquired a social identity; societal perceptions of the appropriate reasons for infanticide, permissible methods, and the symbolic and social meaning of infanticide vary widely, as do methods for disposing the body (Daly and Wilson 1984; Scott 2001; Scrimshaw 1984). Infanticide through neglect may be just as common and, like direct infanticide, may disproportionately affect one gender over another. In the Puebloan Southwest no evidence of infanticide exists either at birth or via postpartum neglect, although both of these are difficult to detect archaeologically. While infanticide is directly reflected in mortality rates, it is a type of conscious population control and individual family planning.

COSTS AND BENEFITS OF CHILDREN

The benefits of children, including prestige, labor, increased social connections, and security in old age, vary with an individual's gender and structural position in the household. Thus, a young first wife in a patrilocal household may be under pressure from her mother-in-law to bear a child, and this act may enhance her position as well as provide future labor, social connections, and old age security. Procreation will still be significant for an additional wife in the same household at a later time—perhaps after the mother-in-law has died—but the pressures and rewards will be slightly different.

High fertility rates are usually found when the costs per child are low and when children become economic participants at a young age (Cleveland 1986; Handwerker 1986; Monsted and Walji 1978; Weil 1986). In households where children make an economic contribution, there is frequently a range of desirable household compositions in terms of both the number of children and the gender balance. Even the order of children may be perceived as important. The household composition may, in fact, be critical to the economic, social, and/or political success of the

household. The position of specific family members in the family or community, as well as their future security, lies in the hands of children.

Because children in all societies are social facilitators, their contributions to the family would have been greater than either their economic roles or their costs. Children make friends, gather gossip and, eventually through marriages, produce ties to other kin groups. The kinds of social groups that predominated in a child's experience would have depended in part on the size and distribution of their age cohort. Thus, where populations are aggregated or during periods or places where episodic high fertility produced a population bubble, the formation of peer groups would be possible. In smaller communities intergenerational ties might have been emphasized. The repercussion of intense interactions within a large peer group include implications for the organization of children's daily work, play, learning, and initiations as well as future relationships and social and political influence as adults.

Analysis of costs and benefits for children in prehispanic Pueblos suggests that, while some costs were inherent in the maintenance of older children, the major costs occurred during pregnancy, childbirth, and the early years of child development. These costs were born primarily by women in the form of health burdens. Balancing these costs were benefits that accrued fairly early and tended to increase with time. Families not only loved their children but valued their labor at a fairly young age (Kamp 2002a). As children matured their economic contributions would have become more substantial, and they, their conjugal families, and offspring would have provided valuable social and political connections as well as a type of old-age insurance (Nugent 1985).

While the exact configuration of the costs and benefits of children are culturally determined, the benefits of children include access to their labor as both young and older children (and perhaps as adults), the alliances that can be forged through marriage, and potential social and political support for their elders. Finally, children may be a source of prestige for their parents, perhaps necessary for individuals to fulfill the religious and social obligations that allow for perpetuation of the group and even the cosmos.

Costs and benefits depend partly upon parenting choices, which are influenced by both physical and social environments. Nicholas Blurton Jones and associates (Blurton Jones 1993; Blurton Jones et al. 1994) compared the parenting strategies of the Hadza and !Kung, finding that environmental factors had a large impact on the nature of children's duties. !Kung resources are sparse and dispersed, making longer gathering expeditions necessary. As a consequence, infants accompany their mothers on gathering expeditions to facilitate breastfeeding. From the time children are weaned until they are about fifteen, they spend most of their time in camp and are

given few duties. In contrast, Hadza food is fairly abundant near the campsites, so Hadza children are given much more freedom, forage in small groups without adult supervision, and are asked to do a variety of tasks. The consequence of these different parenting styles is apparent. The !Kung have lower fertility rates than the Hadza.

The potential costs of children go beyond the basic food, clothing, and other material goods needed to sustain them appropriately. Costs include provision for their ceremonial, religious, and physical needs; the time spent on their care; and risks to the health of the mother. In a cross-cultural study of 186 nonindustrial societies, Alice Schlegel and Herbert Barry III found that in societies where women made greater contributions to subsistence, postpartum taboos on sex tended to last longer, suggesting that a reduction in fertility may be one consequence of labor conflicts between child-raising and other tasks (Schlegel and Barry 1986). Both ethnographic materials and skeletal analyses suggest that women may have been spending considerable time grinding and doing other tasks such as cooking or producing ceramics, while men may have been involved in hunting (Perry 2008). Osteological evidence suggests that the work of Pueblo women was constant and physically demanding (Martin 2000; Ogilvie and Hilton 2011). Nevertheless, skeletal analyses reveal variability in gendered work patterns across both time and space (Stodder, Mowrer, Osterholtz, and Salisbury 2010). The costs of mothers' time can be diminished by a variety of cultural solutions, however. Part of the impact is dependent upon the level of child care seen as necessary and part on who is seen as an appropriate caregiver.

The amount and nature of the work allocated to children depends on social norms, but these, in turn, are often somewhat flexible and change through time and with circumstances. For example, in the United States the amount of work children do has decreased significantly; today the costs of children far exceed their economic productivity in most Western households (Zelizer 1985). Nevertheless, today and in the past, children's work roles vary and depend upon both the relative affluence of the household and household labor needs. Thus, children living on farms or where parents own a small business may contribute more labor than other children, regardless of the economic status of the family. Stodder's (this volume) work on morbidity provides potential insights into problems that some adults may have had performing all of their requisite tasks. Since lameness and elbow eburnation were both common problems, these physical debilities, in addition to other conditions that made adults less able to work, may have transferred some tasks into the hands of children.

Even during early childhood, children can make an economic contribution. While there are developmental limits to what children are able to do at various ages, these are quite flexible, and children are able to participate in many vital

tasks. Children almost universally do, at least in part, particular tasks such as child care (Bradley 1993:93; Whiting and Edwards 1988) and collecting water and firewood (Bradley 1993). Children also run errands, carry messages, and help around the house with a variety of chores, including potentially time-consuming ones. Children can become involved in manufacturing activities at a young age, and especially among foragers, even fairly young children may find a significant proportion of their food as they go about their daily activities either with adults or in groups of children. These gathering activities may be geared specifically to children's own needs and reflect their own capabilities rather than mirroring adult patterns (Bird and Bird 2000), and children may use plants and small animals not normally consumed by adults.

I have argued elsewhere (Kamp 2002a) that in the Puebloan Southwest children were able to make an economic contribution even at a fairly young age, and several studies (Bagwell 2002; Crown 1999, 2002; Kamp 2001a) examine the processes through which children began to learn the manufacturing skills which would allow them to enhance their productivity at a young age as well as prepare them for adulthood. Importantly, however, the amount of participation in these activities may vary in some circumstances (Kamp 2009), depending upon variables such as community size and the perceived safety of the surrounding area. The argument that Puebloan children were productive participants in the economic system rests on several lines of evidence. Cross-cultural ethnographic studies, historic ethnography of Puebloan groups, and personal accounts (Dennis 1940; Hill 1982; Whitman 1947; Wyaco 1998) show that children are frequently allotted certain types of duties. Archaeological evidence allows us to consider the potential congruence of ethnographic patterns with the types of work that were actually performed.

Based on these sources, the most common task for children may have been helping scare predators from the fields. This was a critical and never-ending job, but one requiring little specialized skill or concentration—perhaps ideal for even fairly young children. According to Wayne Dennis (1940:83), by the age of four, Hopi children were making trips to obtain water, although the water containers were smaller than those used by adults. At about the age of eight, Hopi girls began to grind corn (Dennis 1940:41). By puberty, girls were expected to be competent grinders, and grinding corn was a component of puberty ceremonies (Dennis 1940:79). The average Hopi family consumed about a quart of cornmeal a day (Bartlett 1933), and producing this quantity of cornmeal in historic times meant that Pueblo women spent several hours each day grinding corn, making this an ideal task to share with female offspring as soon as they acquired the physical strength and stamina to accomplish it.

The labor of children may be particularly prized when they perform tasks that adults find difficult because of scheduling conflicts. Patricia L. Crown and W. H.

Wills argue that in the northern regions of the pre-Columbian Southwest, ceramics must be made during summer to avoid thermal shock and cracking caused by the exposure of hot pottery to cold air (Crown and Wills 1995). The need to make pots during the agricultural season would have caused scheduling conflicts that may have been alleviated by involving Puebloan children in ceramic production at an early age (Bagwell 2002; Crown 1999, 2002; Kamp 2001a). Studies relying on the analysis of fingerprints (Kamp et al. 1999) and the stylistic analysis of ceramic vessels (Bagwell 2002; Crown 1999, 2002; Kamp 2001a) document a learning sequence that starts with the manufacture of small figurines or vessels used as toys and sometimes involves collaboration with adults, culminating in the production of functional ceramics by middle childhood. This learning trajectory mirrors those documented ethnographically (DeBoer 1990; Donley-Reid 1990; Kramer 1997) and provides the most concrete archaeological evidence of the use of children's labor in the prehispanic Southwest.

The contributions that children would have been able to make to the household economy would have varied, depending upon factors such as the exact nature of the agricultural system, the ruggedness of the surrounding terrain, community size, and whether or not it was a time of conflict. This variability, as well as factors leading to a difference in parental health, would have altered the costs-benefits ratios for children as cultural and/or environmental circumstances differed.

RISK ASSESSMENT

Risk must also be factored into any assessment of fertility. Evidence shows a direct relationship between the risk of death for infants and young children and fertility rates, due to both biological and cultural factors. High death rates are usually offset by high birth rates (Frisancho et al. 1976; Swedlund and Armelagos 1976; Weiss 1973). This is due to both biological processes that restore the fecundity of the mother more rapidly after the death of a fetus or infant and the fact that couples who have experienced child mortality tend not to limit family size (Knodel 1988). High fertility rates lead to a high proportion of young individuals in the population, and if mortality rates are especially high among infants and children, the consequence is an overall increase in the death rate (Preston et al. 2001).

According to ethnographic data, high infant and child mortality act to increase the perceived desirability of additional children. W. Penn Handwerker (1986) found that in Liberia the most common response to the question of why many children were desired was that some of them might die. It was not necessary for the individual to have personally experienced a death; it was sufficient to have known someone who had or to have heard about cases of child mortality. Handwerker

(1986:109) concluded, "Fertility can be expected to remain high as long as reproductive behavior reflects a risk aversion strategy based on fear of losing a critical resource in the form of children." When children are vital to household success, but child and infant mortality is high, it is likely that couples may seek to buffer the possibility of future loss by having large families.

In the Puebloan Southwest, infant and child mortality were high and, generally, women's and children's health tended to be poor; although as mentioned above, there is spatial and temporal variation. In addition to high infant mortality rates, younger children suffered bouts of inadequate nutrition and/or disease that led to periodic interruptions in growth, as revealed by enamel hypoplasias and Harris lines (Sobolik 2002). Anemia, other dietary deficiencies, parasitic diseases, and infections all took their toll, leading Sobolik (2002:151) to comment, "Children's health in the prehistoric Southwest is a contradiction in terms." After age ten, however, health, in at least some communities, appears to improve (Whittlesey 2002).

The bones of the very young, especially infants, are both smaller and less dense, exacerbating preservation issues. Probably more than compensating for this bias is the tendency for many Puebloan groups to bury the very young in rooms rather than in exterior contexts. Excavators are also likely to sample a larger proportion of interior than exterior spaces. Even given these caveats, it is worth noting that while the rate of subadult mortality appears to vary both between regions within the Puebloan Southwest and from site to site, it is high everywhere.

The poor maternal health mentioned earlier also has a deleterious effect on fetal development. Low birth weights in infants may be due to poor maternal nutrition or heavy workloads during the final weeks of pregnancy. Intrauterine growth retardation (IUGR) can reach as high as 50 percent in some developing countries and is one cause of early postnatal deaths (Keen et al. 2003:1597). A study of Black Mesa infants who died at less than a year showed that 23 percent had dental problems that would have developed before birth (Martin 2000:280, 281). Since body size normally remains small in IUGR babies even after sufficient nutrition later in life, some of the generally small stature of southwestern Pueblo dwellers (Whittaker et al. 1999; Palkovich 1980; Sobolik 2002) may be due to the poor nutritional status of mothers. Furthermore, mothers whose own growth was stunted during development also have a tendency to have low birth weight babies (Tanner 1990). Babies born small for their gestational age also have a higher than normal chance of perinatal death (Tanner 1990:42–46). Infants who are full term but of very low birth weight, generally do not reach their full height potential later in life, and very low birth-weight infants may exhibit impairment in mental capacity.

The high risk for early death is illustrated by the case of Grasshopper Pueblo, which has one of the largest, well-studied corpuses of subadult burials. Infants less than a year old represent over 25 percent of the mortuary assemblage (Hinkes 1983). Mortality remains high through the fourth year, with 17 percent of burials in the 1–3.9 age category, yielding a total of about 43 percent of burials classified as being from individuals under 4 years in age. Within the sample of infants and children, high percentages exhibited *cribra orbitalia* (58.5 percent), indicating generalized stress; chronic vitamin D deficiency or scurvy (32.3 percent); probable anemia (50.2 percent); meningeal irritations (72.1 percent); and sinusitis maxillaris and periodontal diseases (68.5 percent) (Schultz et al. 2008). These percentages are all indisputably high, possibly due to a combination of poor housing, inadequate sanitation, and malnutrition (Schultz et al. 2008). The percentage of enamel hypoplasias (22 percent) at Grasshopper Pueblo is low relative to many Puebloan sites. Schultz et al. (2007) surmise that the reason may be poor, rather than good, health, as death may have occurred before hypoplasias had a chance to develop.

At large sites such as Grasshopper Pueblo, there is also considerable variation within the pueblo. Within the main area of the settlement, stress markers among children were lowest in Room Block 3. Late migrants occupied this room block, and their nutritional stress increased through time (Hinkes 1983:168, 177; Schultz et al. 2008). Outliers to the main room block, which were late additions to the pueblo, show an even higher incidence of stress markers than the main room block areas (Reid 1973). Interestingly, given the general assumption that high rates of iron deficiency are associated with corn-based diets, according to bone chemistry analyses, the room block with the highest use of wild plants (Room Block 1) has the highest incidence of stress markers, while Room Block 3, where stress markers are less frequent, was also less reliant on agriculture (Schultz et al. 2008).

While risks associated with health were high, they do not represent the only dangers to children in the prehispanic Southwest. The physical environment may also pose a danger to children due to difficult terrain, dangerous animals, or because of human conflicts. The latter may be of particular interest when considering the prehispanic Southwest. While the degree and nature of violence varied considerably across both time and space, warfare and deaths as a result of violence were widespread (LeBlanc 1999; Nichols and Crown 2008; Rice and LeBlanc 2001; Stodder, Osterholtz, Mowrer, and Chuipka 2010; Schaafsma 2000; Turner and Turner 1999). Interestingly, risk due to health problems and violence may not have covaried. While health at La Plata was generally good in comparison with that in most other Ancestral Puebloan communities, violence, especially toward women, is high (Martin et al. 2001:195–97).

SUMMARY

It is likely that, like most people today, Ancestral Puebloans talked about the number of children they desired and may have used a variety of methods—including abstinence, lactation, and herbal medicines—to delay or space births. If the relative value of children is viewed using a costs-benefits perspective, it becomes clear that for the Puebloans, the periods of high costs and low benefits occurred during pregnancy and childbirth and, to a somewhat lesser extent, infancy. The costs of children were not equally distributed, however. Women disproportionately bore them. The poor nutritional level and high pathogen load that appears to be characteristic of Puebloan life in most sites and time periods put stresses on women's health during pregnancy and nursing and placed women at risk for an early death in childbirth.

The social, symbolic, and personal meaning of children is hard to assess using archaeological evidence, but these were all undoubtedly important in determining the perceived benefits of children. The utility of children's labor is somewhat more accessible using material evidence, although even here the reconstructions are unavoidably somewhat speculative. We do know, however, that as children matured, their labor would have become an important asset to households. Under many circumstances it may well have been to a household's advantage to have a number of older children. The continuation of the family line and a measure of old-age insurance were probably of paramount importance, however, and these benefits did not accrue until offspring reached adulthood.

Assuming that a minimum number of children were desirable for a functioning household, and even more that it was necessary for a minimum number of children to survive into adulthood, parents needed to take the probability of their children dying young into account. In addition to the relative benefits and costs of children, the average number of children born to each woman should vary somewhat with risk. Thus, in periods of higher risk, the fertility rate is predicted to be higher. Because the period of high childhood mortality due to the interrelated variables of poor nutrition and disease was so long, parents could not be reasonably sure that their offspring would live into adulthood until they had reached age ten or so. In the interim it was important for a woman to continue reproducing, making it highly probable that many women would overshoot the number of children needed for simple replacement and causing overall population increase. Periods of conflict further exacerbated the dangers. Thus, the risk of an early death was high and lasted well into childhood, making a high level of fertility necessary in order to buffer the likelihood of children dying early.

Cross-cultural research shows that if the risk factors are somewhat controllable, parenting is expected to adjust by becoming more intense in order to combat the

risk factors, thereby lowering children's risk of harm (Quinlan and Quinlan 2007). When risk factors are so high as to be uncontrollable, and there is little that parents can do to ameliorate risk, the expectation is that parenting techniques will become less intense. At this point it is more important to invest in additional children.

The proposed model suggests that observed temporal and regional variability in fertility rates may be explained by differences in local circumstances, leading to alterations in the costs-benefits ratios and/or perceived uncertainties associated with child raising. A demographic structure with large percentages of young may in itself also tend to exacerbate violence. Cynthia S. Bradley (2002) provides an example where large percentages of older children and young adults may have exacerbated social tensions. She suggests that sporadic population increases produced large cohorts of young males likely to be interested in engaging in war. Such population bubbles would also have placed additional resource pressures in areas where the subsistence system was already stressed. Immediately before the abandonment of Sand Canyon, a mid- to late thirteenth-century Pueblo in the Mesa Verde region, at least twenty individuals appear to have been killed in an episode of violence that is interpreted as either raiding or an internal dispute between factions (Bradley 2002). The dead included all ages, but individuals between twelve and twenty comprised a larger than expected proportion, and Bradley (2002) interprets this as due to an enhanced proclivity for adolescents and young adults to become involved in political and ideological disputes.

A costs-benefits analysis of ancient Puebloan children and the evidence of high subadult mortality suggest a seemingly paradoxical conclusion. A population where many children are born but die quickly, as well as a population where a high percentage of infant burials correspond to many children in a living community, may not be a population under improved conditions. Instead, it may represent one under stress, where families respond to the frequent loss of children by increasing fertility. The prehispanic Southwest provides an excellent test case for this hypothesis. At the moment, however, the data are only suggestive. More fine-grained research that allows costs-benefits, risk, and fertility comparisons between regions and time periods is needed.

Ethnogenesis and Archaeological Demography in Southwest Vecino Society

B. SUNDAY EISELT AND J. ANDREW DARLING

At the end of the Mexican-American War in 1848, the United States acquired vast tracts of land in the former colonies of New Spain inhabited by a native-born population of Hispanics that exceeded 74,000 people. Populations were low in California, Arizona, and Texas, where Hispanic residents barely exceeded 18,000, but New Mexico was another matter. Here, Hispanics numbered over 56,000 and constituted 90 percent of the population. While the presidios and settlements in other areas languished under Spanish and Mexican administration, New Mexican populations soared from the initial seventy families who reoccupied Santa Fe under Diego de Vargas in 1692 (Kessell et al. 1998; Nostrand 1992:38).

New Spanish immigrants augmented the colony following the Reconquest, but migration alone cannot explain *how* and *why* the Hispanic population of New Mexico grew at such a high rate relative to other areas. In this chapter we investigate the demographic drivers that shaped Hispanic ethnogenesis in the region. We discuss the causal factors behind these demographic drivers and argue that ethnogenesis (the appearance of new ethnic or social identities in an area where they did not exist before) is a historical process directed in part by these drivers. Some are external to the process (e.g., slavery, raiding, and economic reforms) and others are internal (e.g., marriage, baptism, and death). Although identity formation may be seen as a new or novel demographic variable that impacts population change (Kulisheck, this volume), it is equally true that ethnogenesis does not occur in a demographic vacuum. Identities do not exist without people. Consequently,

demographic change—the consolidation or decline of regional populations—directly impacts the formation, transformation and, in some cases, the disappearance of social identities (Stojanowski 2005).

Our analysis utilizes a variety of sources for population data, including detailed studies of nomad baptisms (Brugge 1985), the Spanish slave system (Brooks 2002), ethnic and gender studies (Gutiérrez 1991), and historical and population geography (Jones 1996; Nostrand 1992; Tjarks 1978). The compilation of data across these foundational and highly focused works is revealing of the overall demographic process of Vecino ethnogenesis in New Mexico. This process comprises two cultural patterns and archaeological phases of similar temporal duration (roughly 100 years each), which we define as Late Colonial and Vecino. The Late Colonial period is characterized by a stagnant demographic trend punctuated by wide swings in growth and decline, from 1693 to 1790, resulting in almost zero net population gain. The influx of Athabaskan and Plains Indian people, taken through slavery and Spanish warfare, bolstered so-called settler populations, but this was counterbalanced almost equally by deaths through captivity and retribution (raiding and counter-raiding), disease, and drought. The Vecino period, beginning after 1790 and continuing into the first third of the twentieth century, is dramatically different. Starting in the 1790s, exponential population growth and settlement expansion resulted from the consolidation of values and practices that define an emergent Vecino society. An endemic growth pattern takes over, characterized by endogamous unions among “Vecinos,” many, if not most of whom, by this time were of mixed (native and nonnative) descent. Perched on the brink of demographic collapse, the Late Colonial society gave way to a new autonomous society and social identity several decades before Mexican Independence with a stable, growing population.

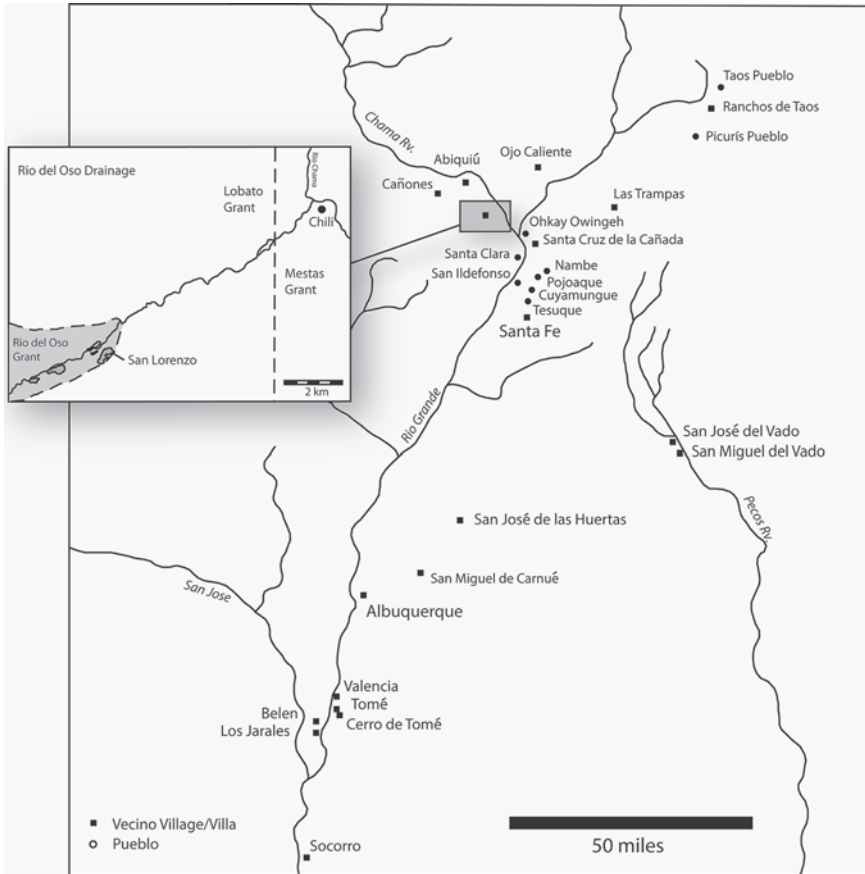
Following Jeremy Kulisheck (this volume), the demographic archaeology of Vecino ethnogenesis is multivariate—combining birth, death, and migration—the material consequences of which impact the entire Northern Rio Grande and can be identified specifically in the archaeological record of the Rio del Oso Valley, above Española. The Río del Oso Grant was settled by the first generation of Reconquest *Espanoles* in 1734 and again in the 1810s by some of their mixed-blood descendants. Reconstruction of the *grant genealogy* (the occupants of the grant and their kin) strongly suggests that filial ties with property, not status or race, conditioned endogamous unions between Vecinos. This case study supports the argument that the shift from a flat demographic trend (resulting in no effective population growth) to a sustained trend in population growth lasting 100 years (or more) after the 1790s represents the establishment of an endemic Hispanic (Vecino) population. Archaeological correlates, including ties to the land through settlement and subsistence, as well as a clearly Hispanic material culture, persist to this day in the Northern Rio Grande.

BEING VECINO

Ross H. Frank (2000) and others (Bustamante 1982; Gonzalez 1969; Swadesh 1974) relate the economic ascendancy of Hispanic villages in Spanish Colonial New Mexico to an emergent self-identity that increasingly differentiated Vecinos (Hispanic citizens) from their Indian neighbors. In early eighteenth-century parlance, Vecinos referred to Spanish neighbors, as opposed to *naturales*, who were “uncivilized,” presumably unbaptized, Pueblo Indians. In its most basic form, a Vecino was a tithes-paying settler with an established household and the legal right to marry other settlers. For non-Vecinos, becoming Vecino required a change in legal status that was based on land ownership and economic achievement. Eligibility also was determined by adherence to the Catholic faith and by behaving like fellow colonials. After reconquest, the system relaxed. Indian, mixed-blood, and *genízaro* individuals could achieve Vecino status through Plains Indian trade and warfare, which brought them the necessary economic success, independent of their position in the local expression of the *Regimen de Castas* (Bustamante 1991). Although the term Vecino might imply a social identity focused exclusively on civic status (Jenks 2011), it is clear that this status also created a social collective centered on land ownership, participation in shared cultural norms, and new opportunities in marriage.

Vecino society developed out of complex multicultural relationships that prevailed during the century following the Pueblo Revolt of 1680 and the later stages of the Spanish colonial empire. Historically, the Rio Grande region, above Santa Fe, was home to the northern Tewa and Tiwa Pueblos, who were distributed in nine separate villages: Santa Clara, Ohkay Owingeh (San Juan), San Ildefonso, Tesuque, Nambé, Cuyamunge, and Pojoaque in the Española Basin and Taos and Picuris in the Sangre de Cristo Mountains to the north and east (map 10.1). Navajo and Ute populations occupied the areas above Abiquiú and Taos, and ancestral Jicarilla Apache bands lived in the mountains and plains of northeastern New Mexico (Eiselt 2012).

By the time of Spanish contact, Taos and Picuris had established a system of mutualistic exchange with their Apache neighbors, but by the end of the seventeenth century, this trade system was severely altered by the introduction of slavery, warfare, and religious suppression (Kessell 1979; Spielmann 1989). The slave system was responsible for transferring thousands of Athabaskans and other plains nomads into the colony, creating a largely disenfranchised, ethnically mixed, and detribalized Indian population (labeled *genízaros* or *castas* by the Spanish) (Brooks 2002; Chavez 1979). Following the reconquest of New Mexico in the 1690s, the colonial administration moved quickly to fortify and consolidate its frontiers, establishing a number of *genízaro* communities at the borders of the colony. By the 1730s, the Jicarilla Apache also established permanent settlements in the Taos area in response



MAP 10.1. Hispanic villages mentioned in the text.

to Comanche aggressions on the Plains and began shifting their economic activities to these newly established villages (Eiselt 2012).

Economic advancement was stimulated even further with the establishment of the Bourbon monarchy in Spain during the early 1700s, whose economic reforms rippled throughout the Spanish colonies. In New Mexico the Bourbon reforms helped to secure the province from warring Plains tribes and provided a market structure that could circulate wealth and capital throughout the colonies while generating taxes owed to the Spanish Crown (Frank 2000). Some of this wealth went directly into Vecino households, but it also provided many opportunities for New Mexican settlers and local heads of household to become legally recognized as Vecinos. In addition to receiving land and money for military service, Vecino

families provided livestock, meat, agricultural produce, salt, tobacco, and textiles for distribution to pacified tribes and were hired to transport these materials to Indian *rancherías*. Government purchases greatly stimulated the growth of vibrant cottage industries in weaving, carpentry, and blacksmithing that by the 1790s quickly became hallmarks of a distinctive Vecino material culture and lifeway (Dickey 1949; Frank 2000).

Being Vecino after 1790 was very different from the legal Vecino status that existed nearly one hundred years earlier. The demographic collapse of the eighteenth century that followed the Comanche raids and a series of epidemics generally undermined local colonial systems of class and status that served to distinguish Vecinos from naturales. Consequently, the Bourbon reforms not only stimulated a significant increase in endogamous marriages among property-owning Vecinos of mixed heritage, they also served to concentrate wealth and property within a new ethnic group whose population began to surge.

POPULATION DYNAMICS

In the following analysis, the social transformations identified above are considered in terms of previously published demographic data and its implications for Vecino archaeology (Eiselt and Darling 2012; Jenks 2011). Population dynamics are readily visualized using census data for the colony in relation to deaths due to raiding and documented patterns of exogamous and endogamous marriages between Vecinos and naturales (see Brugge 1985; Frank 2000; Gutiérrez 1991; Jones 1996; Nostrand 1975, 1980; Tjarks 1978). Population instability due to raiding and disease (that decimated Hispanic and mixed-blood populations), followed by increasing numbers of endogamous Vecino unions (that transformed this decline into a pattern of exponential growth), further consolidated a new ethnic identity that clearly did not exist prior to the late colonial economic reforms. We review this in detail as a means of documenting these demographic trends which, in turn, can be related to changes in settlement and material culture. This discussion proceeds first with a general overview of Vecino population from AD 1700 to 1900, followed by a discussion of the demographic drivers critical to the emergence of an endemic population growth pattern. Archaeological evidence in the Rio del Oso is presented as a case study, which is emblematic of the regional trend in Vecino ethnogenesis that took place in the Northern Rio Grande.

POPULATION OVERVIEW (AD 1700–1900)

Beginning around 1790, Vecino population growth exhibited a sharp exponential rise accompanied by geographic expansion and settlement into a largely Hispanic

(Vecino) homeland (Nostrand 1970). The shift from slow or zero population growth, punctuated by boom-and-bust cycles (AD 1700–1790), to a sustained endemic population (AD 1790–1900) emphasizes the shift from a Late Colonial pattern, which is reliant on captives, to a Vecino pattern, in which individual families are reproductively self-reliant (figure 10.1a).¹

A closer examination of the years prior to the nineteenth century reveals the dynamic cycles of growth and decline leading up to this steady and rapid rise. Calculated growth rates further put these apparent fluctuations into perspective (figure 10.1b). The New Mexico settlements experienced the greatest rate of growth (7 percent) in the 1750s. This type of growth far exceeds the biological capacities of settled agricultural communities (Chamberlain 2006) but can be attributed to a colonial pattern, in which cycles of growth and decline are tied to enslavement (as a means for augmenting population), raiding, and disease. Oscillating demographic rise and decline reached a low point in the 1760s, when the colonial population actually fell by 2.6 percent, only to recover at a paltry rate of 0.2 percent during the following decade.

After the 1790s, in what might be seen as a watershed moment, the annual population growth rate stabilized and began to rise steadily, between 1.8 and 2.3 percent per annum over the next 100 years. Unlike the marked fluctuations that characterized most of the eighteenth century, the post-1790s growth rate is consistent with natural population growth in stable agricultural communities (Chamberlain 2006). More important, the 1790 census marks the first time that the settler and casta population (Hispanics and mixed-bloods combined) turned the demographic corner, rising sharply from 14,416 in 1790 to 56,223 by 1850 (almost tripling in sixty years). This inflection coincides with the beginning of the Vecino phase and associated patterns of material culture and settlement.

Population change is also reflected in the expansion and contraction of Vecino territory through time. During the first forty years after the Reconquest, settlers were distributed in only three villages (Santa Fé, Albuquerque, and Santa Cruz de la Cañada), with individual *estancias* and ranches lining the low-lying farmlands of the Rio Grande. The sharp rise in the annual population growth in the 1740s necessitated the first wave of settlement expansion. Overcrowding and poverty among the colony's freed and enslaved population compelled Spanish authorities to establish eleven new community grants from 1740 to 1765, providing landownership and, as a result, access to legal Vecino status and social mobility to hundreds of castas and *genízaros*. The racial makeup of these villages and grants was highly diverse, demonstrating the polyethnic roots of Vecino society (Brooks 2002). However, the sharp drop in the population during the 1760s and 1770s at the hands of Comanche and Athabaskan raiders forced the abandonment of many settlements and a corresponding decline in landownership over the same period. Some villages, like San

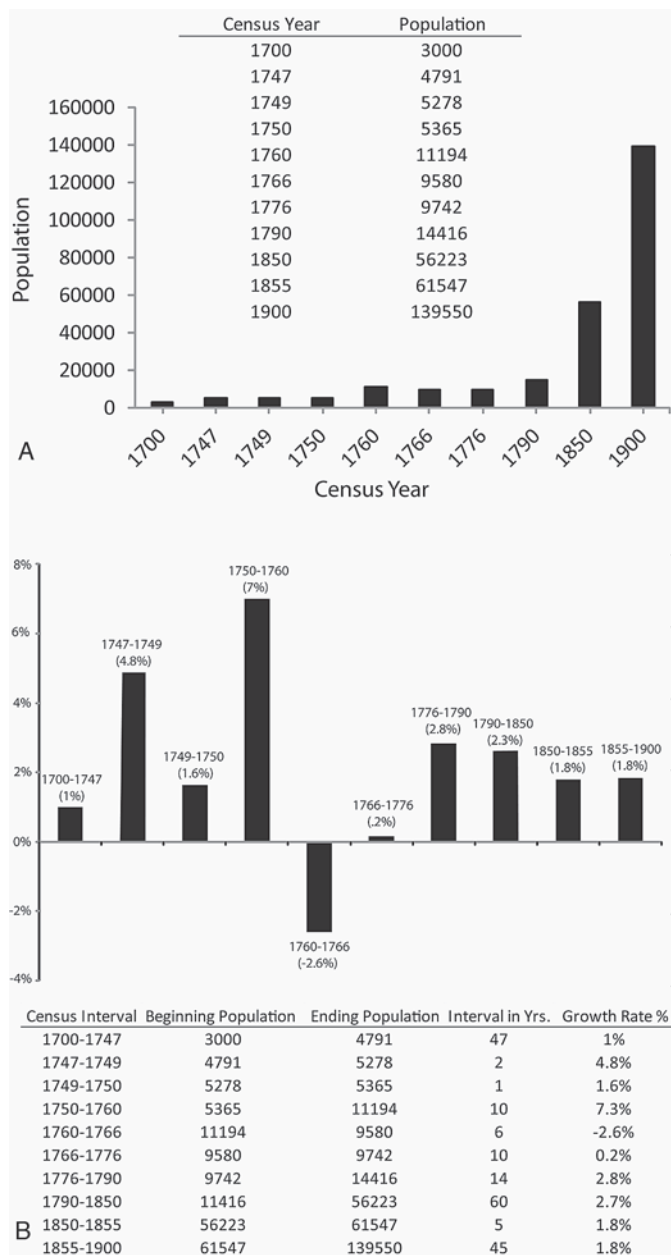


FIGURE 10.1. (a) Demographic profile of Spanish, casta, genízaro, and Vecino populations (1700–1900). (b) Changes in population growth rate from 1700 to 1900.

José de las Huertas and San Miguel de Carnué, were never reoccupied. In other cases, as in Abiquiú, Ranchos de Taos, and Las Trampas, settlers sought temporary protection in the larger villas or nearby Pueblos. Landownership again expanded on a grand scale once the nomadic populations were pacified (relatively) after the late 1780s, leading to the establishment of the highly integrated multicomunity settlement pattern described by John R. Van Ness (1991) and others (Kutsche and Van Ness 1981; Quintana 1991; Snow 1979; Weber 1979).

Land requests show a similar pattern over the same period (Snow 1979). Roughly twenty to twenty-five requests were made every decade from 1699 to about 1775, followed by less than ten requests per decade from 1775 to 1819, indicative of early eighteenth-century attempts by colonial residents to subjugate and occupy new territory but with little success due to raiding and disease. In contrast, the Mexican Territorial Period (1821–1849) witnessed a dramatic increase, including fifty applications for lands in unoccupied locations during the 1820s alone.² Using census data from the 1850s and 1900s, Richard L. Nostrand (1970, 1975, 1980) mapped the expansion of villages and corporate land holdings to the north, south, east, and west from a central core area of population, defining in the process a geographically differentiated Vecino homeland territory centered on the Northern Rio Grande.

DEMOGRAPHIC DRIVERS (AD 1700–1900)

While the previous demographic overview is well suited to an accepted historical narrative, in order for any of this to be relevant to archaeology, demographic drivers must be identified that support these historical inferences. The four drivers proposed here provide an interpretive framework through which regional analysis and hypothesis testing may be conducted. Drivers 1 and 2 are classic to all demographic change (see Kulisheck, this volume), whereas drivers 3 and 4 are unique to the Vecino ethnogenesis.

1. Spanish colonial slave raiding and *reducción* of Native populations (documented by the record of baptisms), significantly augmented Spanish colonial population and may be related directly to the initial pattern of population growth from AD 1700 to 1750 through forced migration and subsequent population explosion in a few small settlements.
2. Population loss due to the combined effects of raiding and epidemics decimated colonial populations starting in the 1760s (based on the records of numbers of settlers killed relative to numbers of recorded nomad baptisms). The introduction of the smallpox vaccine in 1815 (Simmons 2001) helped to lower population death rates due to disease.

3. The economic incentives of the Bourbon reforms, which were instituted soon after the pacification of the Comanche in 1788, encouraged Vecinos to consolidate land and capital through endogamous marriages.
4. The issuance of new land grants after Mexican Independence stimulated population growth and continuous territorial expansion until the close of the US Territorial Period in 1912.

Taken together, these four drivers serve to explain the following demographic trends in population growth and decline and the emergence of a coherent population identifiable as Vecino.

Captivity, Raiding, Drought, and Disease (Demographic Drivers 1 and 2)

Demographic change in the Northern Rio Grande is perhaps best visualized through the record of baptisms and deaths. Since there are no birth records for nomadic peoples captured in raids, the record of their baptisms provide a proxy measure of population growth, as new members joined the colony through the medium of the Catholic Church. Clearly, not all baptisms resulted in permanent occupancy within the colony by these formerly nomadic people, nor do they record the motivations behind the baptisms (e.g., voluntary or forced). Nonetheless, slave raiding and *reducción* (our first driver) contributed enormously to the numbers of baptized individuals in the Spanish population during the eighteenth century, of whom many, if not most, were Athabaskans.

Likewise, population loss or decline may be assessed in terms of settler deaths due to armed conflict and counter-raiding or retribution, which no doubt resulted in changed mortality profiles and (perhaps) fertility. Other sources of population decline, including illness and epidemic, also contributed to decreases in the momentary population of the region (and are noted when they occur). However, it is the tension and contingency that existed between voluntary and forced baptisms of Native people (through slave raids, *reducción*, or captivity) and settler deaths (due to counter-raids) that contributed to an almost level (or stagnant) net population growth prior to the 1790s. Ultimately, those pressures would be relieved, but only after the cessation of hostilities with the Comanche.

Figure 10.2a presents the raw counts of nomad baptisms and settlers killed (by nomads) compiled from Catholic Church records (Brugge 1985). David M. Brugge's study recorded a total of 4,321 nomad baptisms and 897 settlers killed due to raids from 1694 to 1875 (181 years). Two trends stand out. First, 32 percent of all nomad baptisms took place during a short forty-year period from the 1720s to the 1760s. This includes a total of 1,382 conversions, of which 1,011 (73 percent) were Athabaskan (Brugge 1985:22–23). These additions contributed to the sharp rise in

the settler population at this time. The second trend is the peak in settler deaths from raiding during the 1770s and 1780s. A total of 472 individuals were killed during these two decades, mostly at the hands of the Comanche. Not surprisingly, this period of violence corresponds with the dramatic drop in the annual growth rate of the colony, widespread village abandonment, and the congregation of the population into fewer settlements.

The timing of nomad baptisms and settler deaths from raiding also is correlated and provides additional information on the dynamics of population and ethnic realignments in the formation of Vecino society. Figure 10.2b plots a Log transformation of raw counts of nomad baptisms and settler deaths from raiding by decade for 170 years. Visually, it appears that with occasional exceptions, nomad baptisms and settler deaths are correlated. To test the strength of the correlation, we fit a regression line and 0.05 confidence intervals to a bivariate plot of the transformed data (figure 10.2b). The correlation is positive but weak due to several outliers ($r^2 = 0.38$, $F = 9.96$, $p = 0.006$). Outliers indicate a significant lack of fit at four points in time. In two instances—the 1740s and the 1860s—the number of nomad baptisms within the colony relative to settlers killed is significantly higher; whereas in the 1700s (1700–1710) and 1770s, the number of settlers killed relative to nomad baptisms within the colony is significantly higher. Removing the outliers improves the correlation and fit between baptisms and deaths due to raiding ($r^2 = 0.73$, $F = 32.37$, $p = 0.0001$). With the exception of these four decades, the timing of nomad baptisms and settler deaths within the colony is highly correlated.

The statistical outliers also are informative, showing the decades when the colony experienced its greatest population losses and gains at the hands of nomads. The high number of settlers killed from 1700 to 1710 is associated with lingering Apache warfare following the reconquest, whereas the numbers of settlers killed in the 1770s signal the onset of Comanche violence. Additional deaths were the result of smallpox outbreaks and drought. The higher levels of baptisms during the 1740s likewise corresponds with the appearance of the Comanche on the Plains, which drove many of the Plains Apaches into New Mexico.³

Statistical analysis reveals what James F. Brooks (2002:147) and other historians have previously noted. Kinship, slavery, and community were closely intertwined in the creation of post-Colonial endemic populations and identities. Nomads, compelled to integrate into the settlements through captivity, comprised a significant proportion of the *casta* and Vecino segments of the colony, bolstering populations overall. However, the dynamics of captivity (raiding and counter-raiding) suppressed growth and, over the long term, resulted in practically static population gains until the 1790s.

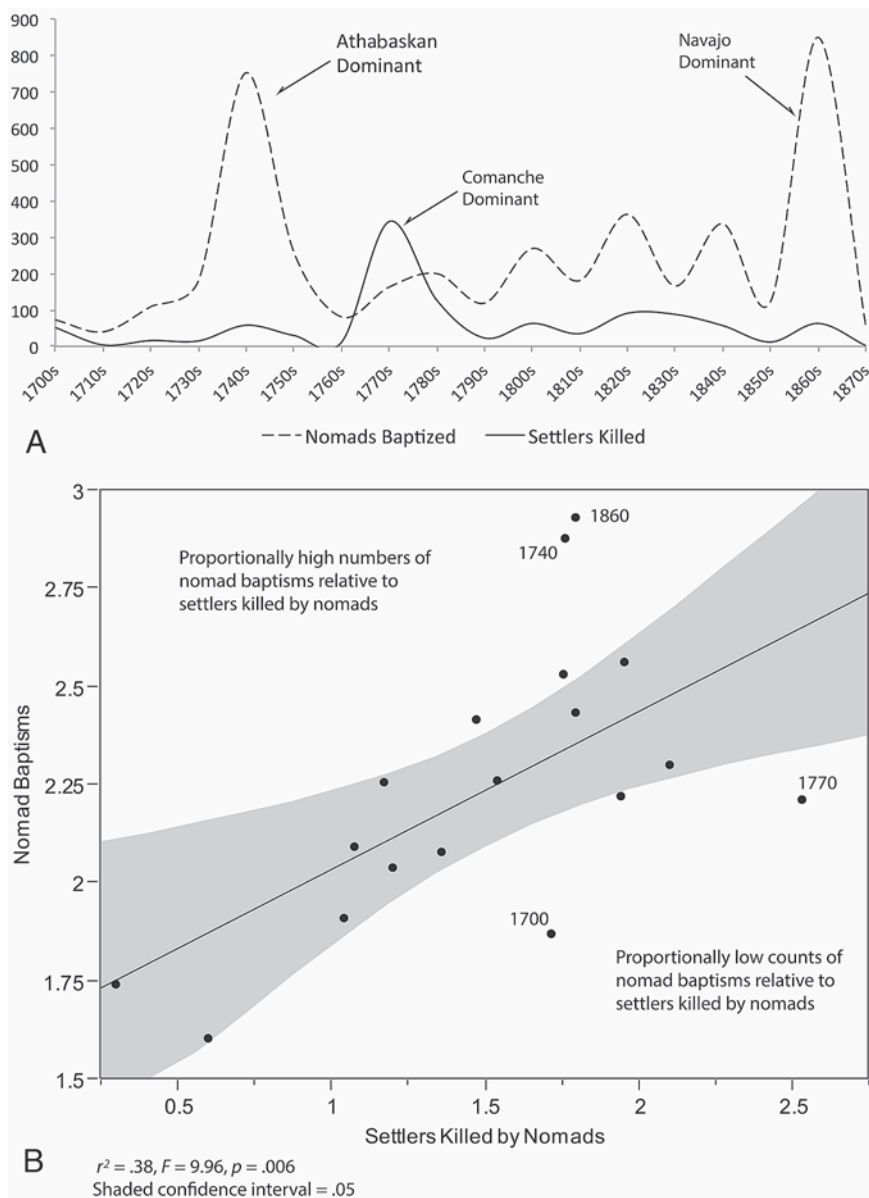


FIGURE 10.2. (a) Nomads baptized relative to settlers killed by nomads, 1700s to 1860s (Brugge 1985). (b) Bivariate plot of log-transformed counts showing positive correlations between nomad baptisms and settler deaths due to raids.

Additional analysis of nomad baptisms also provides another measure of the ethnic roots of Vecino society. Here we limit our discussion to Athabaskan and Shoshone converts because the proportion of other nomads (e.g., Kiowa-Tanoan, Caddoan, Numic, Yuman, and Salish) does not exceed 5 percent of the total sample in all years.⁴ The Athabaskans and especially the Apache contributed greatly to the region's *genízaro* and mixed-blood castes by mid-century, when the population finally reached 5,000. Overall, Athabaskans account for 64 percent of all baptisms ($n = 2,745$ of 4,321), with an even higher contribution during the first half of the eighteenth century (at 73 percent).⁵

The Ute and Comanche form the majority of the remaining baptisms (22 percent), and most of these were Ute Indians from various bands.⁶ The Comanche contributed fewer people, only 5 percent of all baptisms from 1700 to 1875 ($n = 228$ of 4,321). Most of the Ute conversions came after the early 1800s while most of the Comanche baptisms occurred during the war with the Spanish from the 1770s to the 1780s.

The Comanche contributed far more to the decline of New Mexico populations than they ever contributed to its growth. The Comanche had succeeded in reaching New Mexico by the 1740s, and from the 1760s to the 1780s they unleashed a series of deadly attacks against the colony, leading to what Frank (2000) has called a "Defensive Crisis." For the first time, the number of settlers killed far exceeded the number of nomad baptisms. Although New Mexico fared better than Nueva Vizcaya to the south (only 897 deaths were attributed to nomads from the 1700s to the 1870s in New Mexico), fully 52 percent of them took place during this twenty-year period. Twenty-seven percent of these were attributed to the Comanche, while another 59 percent went unattributed, although they were likely Comanche as well. At least thirty separate villages and pueblos suffered repeated attacks (Frank 2000:37). The Athabaskans, by contrast, account for only 14 percent of violent deaths over the same period.

Drought and disease compounded the losses suffered from Comanche raiding, particularly from 1772 to 1776. Raiding intensified in response, further draining the colony of vital livestock and food stores. The rate at which Indian and lower status children were forced into adoptive households also increased dramatically, providing at least some indication of the impacts of drought to infant mortality and health. The smallpox epidemic that hit New Mexico in the winter of 1780 only added to the misery. Although the disease impacted villages differentially, Frank (2000:56) has estimated that it killed up to 25 percent of the non-Indian population within a year. By the mid-1780s, the New Mexico settlements were very close to demographic collapse, but in 1788 peace with the Comanche and new economic incentives offered a reprieve as well as new mechanisms (drivers) for demographic change.

The New Vecino Identity (Demographic Drivers 3 and 4)

While overall demographic patterns can be elucidated in terms of the rise and fall of population relative to deaths and baptisms, marriage patterns offer the third driver, which set the Vecino period and Vecino ethnogenesis in motion. In particular, marriage served to structure demographic change relative to the existing colonial social and economic structure, including issues regarding race, status, and property. This is expressed in the Spanish concept of *calidad*. *Calidad* referred to the quality or essence of a person according to several complementary criteria of social classification, including age, sex, place of residence, race, skin color, birth (legitimacy or illegitimacy), civic status, or occupation. *Calidad* determinations were context dependent. They were used primarily in legal proceedings to evaluate an individual's status relative to their rights and privileges under Spanish law, including the closely related institutions of marriage and property ownership. In contrast, the *Regimen de Castas* referred more specifically to the social order of castes or classes perceived by the Spanish on the basis of blood purity (*limpia de sangre*) or distance from Spanish royal bloodlines (Bustamante 1991). The *Regimen de Castas* was exclusive and immutable, necessitating a bewildering array of terms for mixed-blood combinations that became highly unworkable as the pace of *mestizaje* accelerated during the late 1700s. By contrast, *calidad* was applied more broadly in legal proceedings of all kinds. *Calidad* was situational, inclusive, and mutable. It was derived from an overall impression of social prestige or standing relative to a person's circumstances, some of which could change through the course of a lifetime. It also could be lost or diminished by marrying down or gained through economic achievement (McCaa 1984; Martínez-Alier 1974). The ways in which *calidad* was applied by legal and ecclesiastical authorities—or, alternatively, how it was asserted by petitioners—provides important information about the shifting criteria of social classification in frontier New Mexico and how social mobility conditioned the emergence of a polyethnic Vecino class.

The only documentary body in which *calidad* declarations were consistently reported between 1693 and 1846 was the marriage investigations of the Catholic Church (Gutiérrez 1991:194). During the first half of the century (1700–1760), these records show that civic status, not race, dominated class declarations among marital candidates, hovering between 68 and 90 percent of all marriages (Gutiérrez 1991:196; figure 10.3a). Most of these marriages were endogamous unions between individuals who self-identified as Vecinos (figure 10.3b). Ramon Gutiérrez (1991:282) suggests the pattern of marriage declarations and endogamy was due to the obvious ethnic and racial differences. However, because civic status was favored over other criteria of *calidad*, for those marriages reported, it is difficult to know to what degree marriage partners were, or were not, of mixed

heritage. More importantly, Vecino status declarations (and consequently endogamy among “Vecinos”) rise in tandem with population growth and the extension of land grants and landownership to the casta and genízaro population. This is not surprising. Civic (Vecino) status should be invoked in marriage declarations, particularly when population is on the rise and the exchange or addition of property is implied by the matrimonial contract.

With the decline in the population and the concurrent abandonment of community grants and individual ranches in the 1760s and 1770s, the tendency to invoke civic status over race reverses. Ethnicity and race, not civic status, becomes the primary preoccupation in marriage declarations, rising to 78 percent of matrimonial investigations. Gutiérrez attributes this to a rise in the mixed-blood and casta population and a preoccupation over race mixture among the formerly predominant Spanish landed class, whose decline in numbers undoubtedly made it more difficult to find suitable marriage partners. This preoccupation makes sense when, in prior decades, civic status strongly influenced marital unions, thus encouraging mixed marriages, and ultimately straining the viability of a system based strictly on *calidad*. Furthermore, as population declines the priority for managing property through the institution of marriage becomes less of a concern, leaving perceived categories of race, or *limpia de sangre*, as the principal criteria when choosing a spouse.

The shift in emphasis from civic to racial diagnostics in the determination of *calidad* was a social response to demographic decline based on legal definitions of personhood in New Spain (not on race or, specifically, the *Regimen de Castas*). Maintaining any marital standard based on Spanish descent and *limpia de sangre* would be impossible in northern New Mexico at a time when domestic survival depended as much on successful births as adoption through baptism. As a result, by the middle of the eighteenth century, anyone who was casta may also have been kin or a potential marriage partner, and by the end of the 1700s, civic status—once again—was cited more often in marriage declarations over race or ethnicity.

Frank (2000) relates this process to the emergence of a self-conscious “Vecino” identity that was increasingly defined in cultural terms and in contradistinction to Indians and Pueblos (see also Jenks 2011). However, this is comprehensible from a demographic and legal perspective as well. The assertion of civic status in *calidad* declarations defined the boundaries of individual wealth and personal circumstances where property was involved. More important, landownership encouraged endogamous marriages and a population growth pattern in which the successful union of Vecinos (as property owners or propertied families) superseded all preoccupation with Spanish or Indian descent. This was particularly true under the Bourbon monarchy and even more so as Mexican independence ushered in a new era of land grants and economic incentives (the fourth demographic driver) that

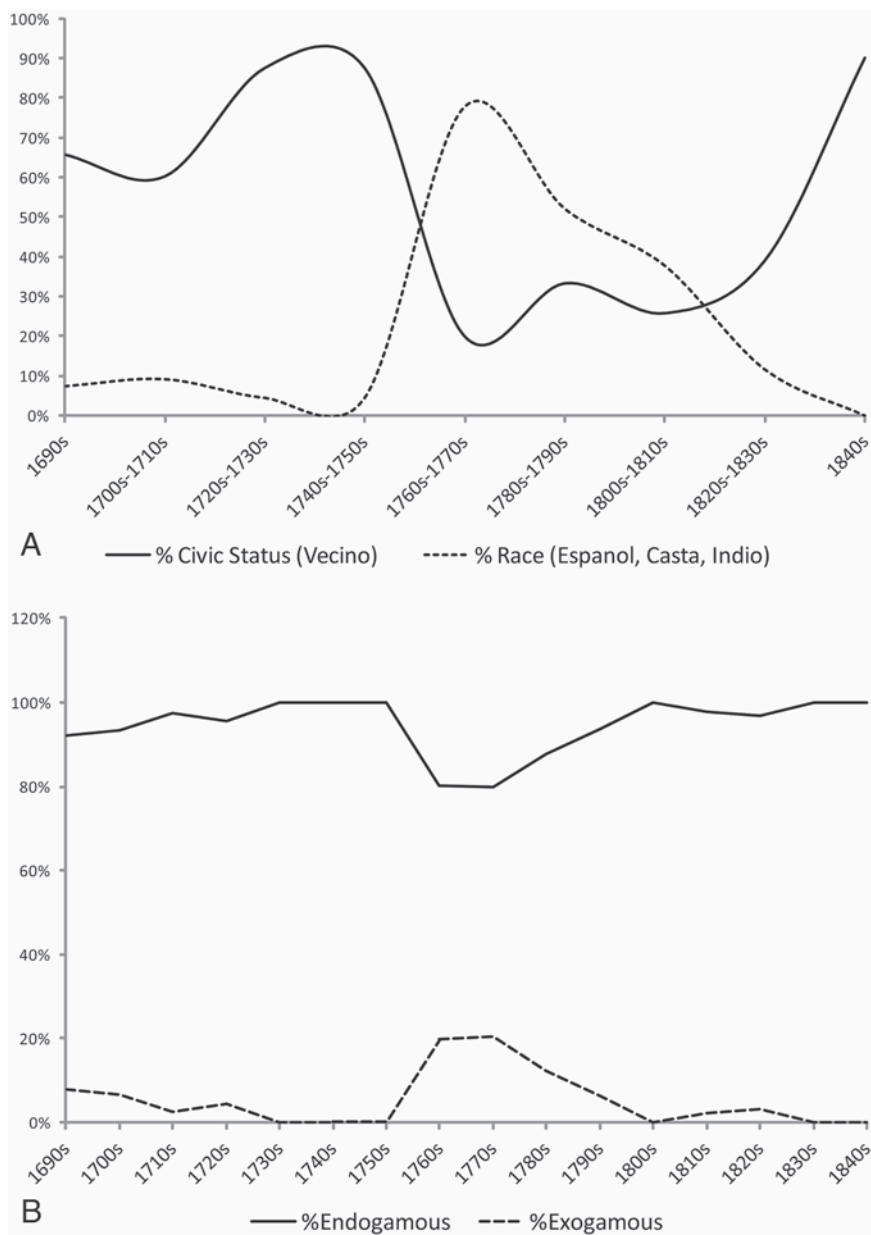


FIGURE 10.3. (a) Percent of calidad declarations in matrimonial investigations, 1700s to 1840s (Gutiérrez 1991). (b) Percent of endogamous and exogamous marriages, 1700s to 1840s (Gutiérrez 1991).

supported advantageous unions among Vecino families and concentrated land and capital among related extended family groups.

VECINOS IN THE RIO DEL OSO VALLEY

Archaeological data provide some of the best evidence for the emergence of an endemic growth pattern in Vecino populations relative to the land grant system. The Colonial and Vecino periods are well represented in the Rio del Oso Valley, north of Española, and can be related to different dateable components of the record in the valley. We employ a novel methodology to reconstruct the genealogy of the Rio del Oso grant and examine the relationships between civic status, marriage, and kinship in the occupation of new lands, showing in the process how the results of ethnogenesis (new social collectives) are reflected in the archaeological record.

The Rio del Oso watershed was encompassed by three successive land grants. The first was given to Juan Manuel de Herrera, Roque Jacinto Jaramillo, and Rosalía Valdez, with her two sons, Juan Valdez and Ignacio Valdez, in 1734.⁷ This grant was temporarily abandoned in 1736 due to a Ute raid, leading Rosalía and her sons to relocate closer to Abiquiú in 1737 (Quintana 1991:16). Jaramillo and Herrera stayed, reaffirming the grant in 1746. The 1744 census by Fray Miguel de Menchero indicates that the Rancho de Chama and Rio del Oso had either eleven families (Jones 1996:123) or seventeen families (Hackett 1937:399) at the time. Further depredations by the Comanche in 1747 led most of the early settlers of the Abiquiú area to abandon their farms, but Jaramillo appears to have maintained his interest, purchasing shares from the others who left, presumably due to the lack of water for farming. Other documents indicate that Jaramillo used the valley as pasturage and was not a permanent occupant but that his children had built some structures and were farming in the valley in 1762. Jaramillo lost his claim to the grant the following year after becoming entangled in an unrelated dispute over the adjoining Vallecitos grant. The Rio del Oso grant reverted to public domain in 1763 and was held in trust by Juan José Lobato, *alcalde mayor* of Santa Cruz de la Cañada.⁸

Almost fifty years later, in 1810, eleven families led by José Antonio Valdez petitioned, and were awarded, an in-holding within the larger Lobato Grant, which soon became known as the settlement of San Lorenzo. Grant documents and historic maps fix the boundaries of the San Lorenzo grant relative to the Lobato and neighboring Maestas grants (see map 10.1 inset). The US Court of Private Land Claims extinguished title to this grant in 1890, effectively ending the Hispanic occupation of the valley.

The grant history sufficiently brackets the Hispanic occupation of the Rio del Oso in terms of the Late Colonial and Vecino phases, identified demographically.

Archaeological survey further reveals two Hispanic components and a series of Jicarilla Apache encampments. The early Hispanic component pertains to the Jaramillo-Herrera-Valdez grant and consists of three household complexes surrounded by hundreds of meters of rock walls lining the agricultural terraces of Pesedeuinge, a Classic period pueblo. Settlers built this extensive network of walled terraces from rock cleared from the fields and scavenged from Puebloan structures and features. The walls are substantial—70 centimeters wide at the base by 70 centimeters high in many places—and are constructed of large boulders that would have required draft animal transport. Most of the walled fields are located on the second and third terraces above the valley floor in areas that would have required rainwater farming to be productive, further supporting the contention that they also served as pastures. The household complexes are simple, consisting of a single linear room block associated with an *horno* (outdoor oven) base and a rock-built *torreon* (look-out) several meters in diameter. Households are placed on top of Puebloan ruins in strategic overlooks on the south side of the drainage. Structure foundations are carefully built with large and small interlocking boulders and cobbles. Artifacts are rare to nonexistent.

The nineteenth-century component includes one large multi-dwelling settlement identified as San Lorenzo on historic maps, plus three other sites or isolated household complexes associated with livestock pens and rock-lined fields. San Lorenzo household complexes display the “classic” nineteenth-century site layout, consisting of a small linear or L-shaped room block associated with a substantial stone *fuerte* (storage facility) and surrounded by a rock-lined courtyard with external trash accumulations (Wozniak et al. 1992). Structures are smaller and less substantial jacales, with expedient stone foundations. Unlike the earlier component, sites are located on both sides of the drainage in areas outside major Puebloan occupations. The later residents also made greater use of the valley, as evidenced by isolated structures, wagon roads, trails, and rock art. Torreons and hornos are not part of this record and sites are not situated in strategic overlooks. Moreover, artifacts show the integration of Native American material culture in men’s and women’s activities. This includes evidence of plain (gray ware) and micaceous ceramic production by Vecino women (Eiselt and Darling 2012), the use of expedient stone tools for cutting and gunflints, milling equipment scavenged from Puebloan sites, and debris from tin working. Additional evidence for regular trade interactions with Indian people includes Tewa plain ware and decorated ceramics, Jicarilla micaceous cookware, and metal arrow points also obtained from the Jicarilla.

The residents of San Lorenzo carried on a brisk trade in metals and ceramics with the Saitinde band of the Jicarilla, who also occupied the valley starting in the mid-1800s. Jicarilla encampments are located on the north side of the valley and overlap

the boundaries of the grant. These settlements likely represent several extended families of around forty to fifty people, although the Jicarilla ceremonial feast day (*Gojia*), which was celebrated at the mouth of the Oso, brought additional families prior to the fall hunt in the Jemez Mountains (Eiselt 2012).

The settlement pattern of the Hispanic components demonstrates the marked contrast between the Spanish Colonial and Vecino archaeological records. The first-generation descendants of Spanish individuals from Mexico City, Zacatecas, and the El Paso exile colony created the early component.⁹ The associated archaeological record exhibits a settlement pattern oriented toward quasi-military occupation, which is defensive in nature and situated on top of late Pueblo archaeological sites, while focusing on exploitation of the valley for large-scale stock management and farming. The latter component represents a Vecino settlement pattern, which lacks the defensive posture and is more fully incorporated into the surrounding landscape. The later grant emphasized an integrated subsistence-settlement economy, with significant Indian input in technology and trade.

Several additional observations are derived from genealogical reconstructions of the grant owners (figure 10.4).¹⁰ The later occupation of San Lorenzo was established in 1810 by sibling sets—brothers and sisters who were descended from the original grant families. This pattern of sibling recolonization provides compelling insights regarding the role of kinship in the expansion of Vecino settlement in the splinter-diffusion fashion documented by Kenneth R. Weber (1979). Furthermore, additional examination of descendent family trees reveals the incorporation of mixed-blood relatives, particularly an increasing Athabaskan presence in families living in the Rio del Oso alongside ethnic Ollero Apache. Clearly mestizo, the importance that these later families placed on maintaining ancestral ties with the Spanish Colonial families who established the grant is significant, but only insofar as this was necessary for maintaining filial ties with property. With the American period relocation of the Jicarilla Apache to their current reservation at Dulce and the removal of these lands from Vecino ownership, these associations were abruptly severed but not forgotten by either descendant community.

VECINO ETHNOGENESIS

Our discussion has focused on the cycles of demographic growth and collapse in the creation of the Vecino cultural pattern in New Mexico. In the process we have shown that slavery and miscegenation were driving forces in the population dynamics of the eighteenth century; but by the turn of the nineteenth century, the Bourbon Reforms in New Mexico had a stabilizing effect, leading to the development of a new and endemic population of Vecinos. Demographic trends

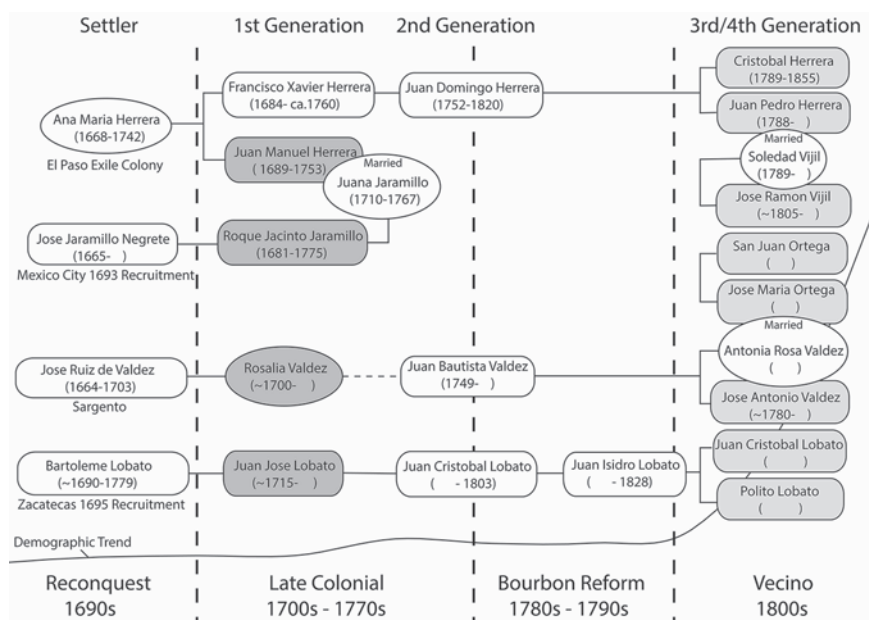


FIGURE 10.4. Rio del Oso grant genealogy.

mark the transition from Late Colonial to Vecino periods, both historically and archaeologically. Athabaskans comprised the majority of baptisms during the Late Colonial period, with numbers as high as 73 percent during the first forty years of the Reconquest, leading, in turn, to overcrowding in major villages, the need for defensive settlement on the periphery of the colony, and the extension of landownership to detribalized and genízaro populations. With landownership came Vecino status; a trend that was reversed, temporarily, with the near demographic collapse of the 1760s and 1770s, when populations became increasingly ethnically mixed and a preoccupation with race ensued. Subsequent to this, in two short decades concerns over race subside. Civic status returned as a primary concern for establishing economically advantageous, endogamous unions among mixed-blood Vecinos. Correlations in the cycles of baptisms and deaths (most due to raiding) demonstrate the ways in which slavery and captivity transformed the colony demographically, not only in terms of race and class but also civic status and the rationale for land inheritance and property-holding rights.

The consolidation of property through marriages among landholding Vecinos encouraged sustained population growth and settlement expansion from the 1790s to the late 1800s. By the early 1800s, Vecinos were marrying within landholding

groups in order to extend control over territory and integrate the economies of neighboring grants. Land inheritance and property-holding rights rendered the *casta* system obsolete and a recognizable Vecino settlement pattern and material culture was in evidence. Filial ties with property, not status or race, conditioned the emergence of an endemic Vecino population, with Spanish colonial roots embedded deeply in Native American soil.

When viewed demographically, the need for favorable endogamous unions to consolidate and hold property promoted the process of Vecino ethnogenesis and replaced arcane marriage conventions of the preceding Spanish colony. Ultimately, the disappropriation of land by the US Court of Private Land Claims, starting in the 1890s, had its greatest impact on the Vecino family networks that were the basis of rural land grant subsistence, material wealth, and historic Vecino identity. Nevertheless, descendent Vecinos, like their Native American neighbors and relatives, continue to maintain their cultural traditions and persist in their claims to the land that once was theirs.

NOTE

1. For example, the long-term trend in figure 10.1a shows relatively stagnant growth—not exceeding 15,000 people prior to the 1790s—to a sharp, exponential rise in the population over the next one hundred years. These figures include population counts for non-Indian and detribalized populations above El Paso (Spanish, *casta*, *genízaro*, and Vecino individuals) for sporadic years through the eighteenth and nineteenth centuries.

2. Landownership was also facilitated by the 1822 Plan of Iguala, which extended Mexican citizenship to all individuals regardless of their ethnic or economic consequences. The new administration, eager to secure the loyalties of the population under Mexican rule, further undertook a broad program of reaffirming titles to grants during the 1840s.

3. The 1860s surge in baptisms is almost entirely the result of American military involvement in the Navajo wars (Brugge 1985).

4. For example, the Kiowa, who are frequently featured in historical accounts of the *genízaro* (Chavez 1979; Magnaghi 1990), account for only 1.6 percent of all baptisms ($n = 67$ of 4,321) and only 0.22 percent of all kills ($n = 2$ of 897). We should also note that the Pueblo conversions account for 17 percent, many of which were Hopi or Hopi-Tewa returning from their sojourn on First Mesa in the 1740s and 1750s (Brugge 1985:24). Some of these individuals were settled with the *genízaro* population at Abiquíu.

5. Seventy-seven percent of these were Apache and the remaining 23 percent were Navajo. The mid-century trend peaked in the 1740s, when a large number of nomads (752 in all) were baptized. The majority of these baptisms ($n = 502$, or 67 percent) also were Athabaskan. Although many of the Apache conversions stemmed from their attempts to

seek protection from the Comanche or, in turn, ally with the Spanish against them, many of these individuals nonetheless remained in the colony, becoming part of the population. The Jicarilla and Carlana Apache, for example, moved into the northern frontier settlements and accepted baptism at Taos in the 1720s, once they were denied a presidio on the Plains. All 178 of the Navajo baptisms in the 1740s also were the result of voluntary conversions at the Cebolleta and Encinal missions (Brooks 2002:147).

6. Ute baptisms consist of 76 percent of the total number of Ute and Comanche baptisms combined.

7. Herrera, Jaramillo, and Valdez were unrelated. Two other individuals, Vincenzo Jirón and Joseph Gomes, are also listed as living on the grant in some of the land grant documents. Ygnacio Valdez likely never settled on the grant, even though he was a petitioner, and Jaramillo may have joined somewhat later, between 1737 and 1746.

8. Frances L. Swadesh (1974:212) points out that, as the ranking civil servant of this district, Lobato frequently took possession of lands that settlers forfeited during Indian raids and that he later put settlers in possession of lands claimed in his name. Although it is unclear whether Lobato actually occupied this grant (as required by Spanish law), he did sell portions to neighboring landowners. A certain amount of land speculation therefore clouds the history of the Rio del Oso Valley and its relation to the larger Lobato grant that encompassed it.

9. Jaramillo's father, a brickmason, was recruited by Diego de Vargas in 1693. Rosalía's father was a captain, killed at the Zuni mission in 1700 while singing a hymn in the church after mass. Juan Manuel's mother and stepfather both lost their spouses in the Pueblo Revolt but joined their families in marriage while in exile.

10. Using land grant documents and baptism, marriage, and death records, we were able to piece together and trace the family histories of eight of the eleven petitioners. José Antonio Valdez was the third son of Juan Bautista Valdez, whose parents were unknown but who appears to have grown up in the Rosalía Valdez household near Abiquiú. Juan Bautista founded the Cañones community to the west of the Rio del Oso grant. Jose Antonio's sister, Antonia Rosa Valdez, was married to Jose Maria Ortega, who was born in Chili, at the mouth of the Oso, a stone's throw away, along with his brother, San Juan Ortega. Both of these men were petitioners on the grant, connected to Valdez by marriage. The parents of their maternal grandmother are currently unknown. Cristobal and Juan Pedro Herrera were brothers as well and were related to Juan Manuel Herrera, one of the original eighteenth-century settlers. Juan Manuel was Cristobal and Juan Pedro's great-uncle on their father's side. Moreover, Juan Manuel had married Roque Jaramillo's second daughter in the 1750s. Her mother also is currently unknown. Juan Cristobal and Polito Lobato comprised the final sibling set, whose great-grandfather was Juan José Lobato, the *alcalde mayor* who terminated the Herrera-Jaramillo grant in the 1760s. Their mother is currently unknown.

II

The Stress of History

Stories of an Unfinished Kiva

SEVERIN M. FOWLES

Southwest archaeology, of late, has displayed notable temperance in its development of theory. Whereas new intellectual currents often enter archaeological conversations like flash floods, blasting away all the hard-won insights that came before, theory tends to lap Southwest shores in less destructive waves that reshape knowledge but still leave standing the core questions that animated scholarship in former generations. Hence, Michelle Hegmon's (2003) assessment of the state of archaeological theory in the Southwest (and in North America generally) as "processual plus." Certainly there are reasons to approach this assessment critically; "plusism" may indeed project a normative picture that undercuts the radical critique of archaeology—a critique that, for some, remains pressing unfinished business (see Moss 2005; Ramenofsky and Herhahn, this volume). But there are virtues to being "plus" as well, not least of which is that it escapes the cascade of revolutionary manifestos and permits old questions to be progressively made new again.

It is in this spirit that I propose to revisit a driving demographic question of the 1980s and early 1990s—namely, scalar stress and its influence on the decision-making organizations of politically autonomous villages—in light of more recent conversations regarding migration, ethnogenesis, and historical identity. In doing so, I am interested in contributing to a rapprochement between two distinct moments in archaeological theory in the Southwest: the first, a "processual" moment (broadly conceived), during which quantification and the search for universal patterns in human organization were strongly valued; the second, a

more humanistic moment (also broadly conceived), which, since the mid-1990s, has led many Southwest archaeologists to attend to history rather than evolution, agency rather than behavior, identities rather than numbers, community rather than complexity, heritage sites rather than natural laboratories, and descendants' accounts of their own indigenous past rather than ethnological comparisons between ancestral Pueblos and historically unrelated tribal peoples who happen to live in vaguely Pueblo-like settlements.

Superficially, the contrast between these two intellectual moments may look like the old opposition between processual and post-processual archaeologies—that is, between an earlier, homegrown body of (more scientific) theory and a later body of (more humanistic) theory imported from Britain and influenced, to a greater or lesser extent, by continental philosophy. By my reading, however, this characterization is quite incorrect, not only because there never actually was a British Invasion in Southwest archaeological theory (which goes without saying in the Southwest but is news to some British colleagues) but because such a characterization obscures the profound influence of the Native American Graves Protection and Repatriation Act (NAGPRA)—and the new world of decolonization it stands for—on the course of American archaeology, particularly in the Southwest.

In fact, most of the major intellectual trends within the more humanistic research of the past twenty years can be understood, at least in part, as a response to the new obligations to engage Native American communities as key stakeholders in the archaeological project, with legitimate concerns regarding the treatment of their ancestors, with legal rights to their own cultural heritage, and with an epistemological authority that affirms the basic reality of indigenous knowledge about their own past. It goes without saying, perhaps, that contemporary research into ethnogenesis, migration, historical contingency, and oral history has been deeply marked by the legal discourse of cultural affiliation. One could also argue, however, that the growing southwestern commitments to the study of religion, cosmology, memory, agency, phenomenology, and the like are also inescapably bound to the new logics of on-site consultations with descendant communities and the new politics of the sacred encoded in the language and practice of NAGPRA itself.

My point is that shifts in Southwest archaeological theory often seem less a product of intellectual revolution than a practical response to an unfolding politics of decolonization by an intellectual community that remains committed to certain core research commitments of long standing. This is what plusism seems to signify more than anything else: archaeological pragmatism.

NUMBERS WITHOUT HISTORY

Consider one of the most promising lines of inquiry during the 1980s and early 1990s: the relationship between population scale, decision-making stress, and the organizational structures that arise to manage that stress. This was a classic processualist research subject, focused on the development of cross-cultural generalizations and premised on the notion that quantification is a necessary step in the explanatory process. As initially argued by Gregory A. Johnson (1978, 1982), scalar stress theory built from the assumption that there are universal cognitive limitations to group information-processing and that these limitations result in predictable thresholds beyond which the addition of extra participants exponentially impairs the decision-making process, all else being equal. The theory further proposed that there are a limited number of strategies available to reduce organizational stress and thereby accommodate scalar increase: a community might develop a bottom-up or sequential form of consensus-based hierarchy, in which small groups of representatives gather to make decisions on behalf of large collectivities; it might institute a permanent, top-down hierarchical structure, with centralized leaders empowered to make unilateral decisions; and as a supplement to both of these strategies, a community might develop ceremonial practices in which routinized behaviors temporarily facilitate information flow (for recent refinements, see Feinman 2011). By the mid-1990s, Southwest archaeologists were more than a little familiar with these propositions (see, e.g., Wills and Leonard 1994; Fish and Reid 1996).

Needless to say, such research chafes awkwardly against Southwest archaeology's more recent theoretical orientations, not least because the heavy emphasis on quantification within scalar stress studies was deployed precisely to eliminate all the cultural specificities that now assume center stage in more humanistic approaches. Whether the individuals in a given scalar stress case were Chacoan or Athabaskan or Russian or French is supposed to be irrelevant to the analysis of why they are increasingly likely to fission or develop autocratic chiefs as their community grows beyond about 2,500 people. Nor is it supposed to matter if the individuals in question lived in P I, II, III, or IV times. On the contrary, the so-called magic numbers of scalar stress theory are magic precisely because they wield mysterious biological and cognitive powers that transcend cultural and historical differences. Little matter who you are; if you try to make a decision with greater than six other person-units, it is going to get progressively more difficult. And if you try to make a decision with fifteen or more other person-units, you are going to be compelled—by the agency of the numbers themselves—to elect a leader.

In certain archaeological circles this basic erasure of cultural and historic difference would be grounds for aborting scalar stress research altogether. Not in the Southwest. Changing theoretical commitments have indeed drawn attention to

some of the limitations of scalar stress research. Andrew I. Duff (2002:18), for instance, observed that whereas “the power of Johnson’s scalar-stress model is that it predicts thresholds where decision-making stresses are likely to require some type of structural adjustment . . . The drawback of the scalar stress model is that it fails to account for agency and individuals” (a concern anticipated by Lipe 1994:143). But Duff does not intend this as an irredeemable critique. Indeed, his southwestern sensibility rings through as he proceeds to propose, on the contrary, that “Johnson’s model is [or, rather, can be made to be] compatible with social agency approaches.” This is plusism in practice.

In fact, there have been a number of efforts within Southwest archaeology to hold onto the fact of certain broadly universal scalar thresholds in human political organization, while simultaneously resisting the temptation to explain away individual and community differences when accounting for such patterns. In an influential article, Gary M. Feinman et al. sought to refine Johnson’s distinction between sequential and simultaneous hierarchies by imagining a continuum between corporate and network strategies, partly in an effort to refocus attention on the actions of variously situated political players (Feinman et al. 2000). More recently, Margaret C. Nelson et al. have expressly proposed that we consider “social diversity” (measured southwestern style, in terms of ceramic variability) alongside population density, both in our analyses of scalar stress and in our explanations of the “dramatic social, economic, political, and demographic transformations” that emerge out of efforts to deal with such stress (Nelson et al. 2011).

To these ongoing calls to consider “political” and “social” diversity, I propose we add a serious engagement with another key variable: *historical* diversity, or rather the sway of history on social identities, on community organization, and on the experience of decision-making stress itself. “History matters,” emphasize Catherine M. Cameron and Andrew Duff, following Timothy R. Pauketat (2001), “because prior actions or negotiations shape and constrain later options” (Cameron and Duff 2008:50). Which is to say, “men make their own history, but not just as they please. They do not choose the circumstances for themselves, but have to work upon circumstances as they find them, have to fashion the material handed down by the past. The tradition of all the dead generations weighs like a nightmare on the brain of the living” (Marx 1926:23).

What does this mean for scalar stress research? Consider, if you will, what is exposed the moment we stop thinking in abstract terms about “six decision-making units” and instead imagine three Israelis and three Palestinians around a table attempting to engage in consensus-based decision-making over what to do in the West Bank. Or, for that matter, consider how irrelevant our scalar threshold arguments become when we imagine three Democrats and three Republicans

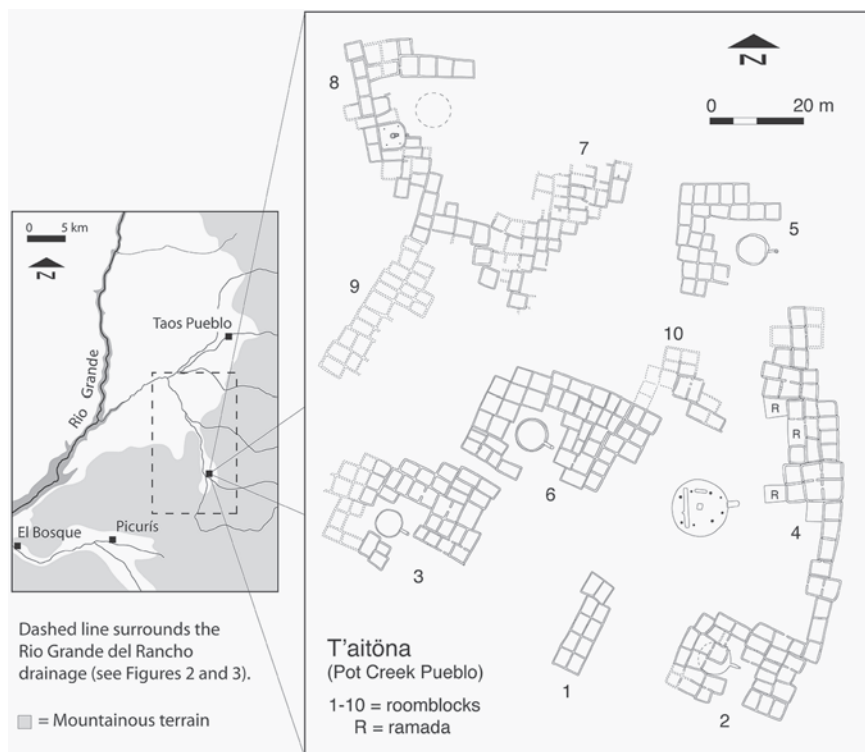
sitting down to reach consensus on just about anything. Needless to say, we can still feel entirely confident in our assumption that decision-making stress is influenced by the number of those sitting around a table (a mixed committee of fifteen Democrats and Republicans would surely have even greater difficulty coming to consensus than a gang of six), but this should not blind us to the obvious fact that historical experiences also have their effects and that, in many cases, the *greatest* decision-making stress stems from past, not present, circumstances. History may not weigh like a nightmare on the brain of numbers, but it surely burdens flesh-and-blood humans as they try to get on in the world together.

I offer these comments in the spirit of plusism. The explanatory power of scalar stress models will only be enhanced once history is added back in and we are able to supplement our population estimates with what we might call a demographics of historical difference. There is nothing unusual or provocative about this move. Demographers have always been interested in quantifying more than just biological variables like life expectancy or the number of male household heads. They have always been interested in, for instance, the percentage of Muslim immigrants in the Netherlands, precisely because statistics of the latter sort shed important light on political negotiations within a community. As archaeologists, there is no reason why we should not consider this broader spectrum of variables as well when we talk about the demographic causes of “information-processing stress” in archaeological contexts. This is particularly true in the Southwest, where decades of research have documented the Ancestral Pueblos’ penchant for migration as well as the centrality of movement within Pueblo ontology. By implication, we can safely assume that individuals with quite divergent historical experiences lived side-by-side at many if not most pre-Columbian Pueblo villages.

The question, then, is how to undertake a demographics of historical difference.

TALLYING UP T’AITÖNA

We can address this question through the case of T’aitöna (aka Pot Creek Pueblo), an important late thirteenth- and early fourteenth-century settlement near Taos, New Mexico, that has been the focus of the longest program of continuous research in the Eastern Pueblo region (map 11.1). Excavations began in 1957; the first syntheses appeared in the late 1960s; and work at the site and surrounding region has continued apace since then (see references in Fowles 2013). This long history of research makes T’aitöna interesting for two reasons. First, it has resulted in rich and varied databases that permit us to discuss population issues with impressive resolution. Second, research at the site spans the two moments in the development of Southwest theory I am interested in bridging. As such, T’aitöna provides us with



MAP II.1. T'aitōna (Pot Creek Pueblo, LA 260).

an unusual opportunity to examine how scalar stress modeling can be advanced, not just through the collection of new data but also by the incorporation of new theoretical orientations.

SCALAR STRESS MODELING IN THE 1990S

The early 1990s, as I have noted, were the heyday of scalar stress modeling. By this time three decades of excavation had resulted in a detailed understanding of the architecture in the southern and western portions of T'aitōna, which benefited from both the exposure of large contiguous blocks of rooms (the lack of a sampling strategy in the early days of research at the site is a mixed blessing) as well as an important new synthesis of the site's extensive tree-ring record, spearheaded by Patricia L. Crown (1990, 1991). A dozen or so earlier Valdez phase and Pot Creek phase sites (AD 1050–1260) in the surrounding Rio Grande del Rancho drainage

had also been excavated, providing a sense of T'aitöna's position as the culmination of a 250-year occupation of the region (Green 1976; Herold 1968; Woosley 1986). Consequently, the development of T'aitöna as an aggregated community seemed relatively well understood. An initially small and dispersed regional population appeared to have converged on T'aitöna during the mid-thirteenth century. From AD 1260 to 1310, the village developed slowly, with the addition of new architectural features (notably small kivas and specialized grinding rooms) but with little overall population growth. Sometime around AD 1310, population increased markedly, probably through immigration, resulting in a much denser architectural complex of roughly 300 ground-floor rooms with a centrally located plaza and large kiva. Soon thereafter, perhaps as early as 1319, the village and its surrounding countryside were entirely vacated—abruptly, it seems, insofar as the large kiva was still in the final stages of construction.

Crown and Timothy Kohler first presented this account of the development of T'aitöna in the second Southwest Symposium in 1990. It was then published in *The Ancient Southwestern Community* (Wills and Leonard 1994) as part of a broader conversation about population aggregation and community organization that bore the strong influence of Johnson's scalar stress approach (Crown and Kohler 1994). And it sought to address three research questions of interest to scholars across the Southwest: (1) Why did village aggregation occur? (2) How were increases in community scale and density accommodated at an organizational level? (3) Why were so many aggregated villages abandoned after only two or three generations? Needless to say, plenty of new research in the Southwest continues to work on these questions. But the studies undertaken during the 1980s and 1990s tended to be distinguished by their use of population scale as a *causal* variable in the explanation of social change.

Crown and Kohler drew upon an impressively large record of excavated rooms and associated tree-ring dates to track changes in both the size and organization of the resident population at T'aitöna. They concluded that while local population increase did not appear to prompt the initial shift toward aggregated village life (see also Crown et al. 1996), a later wave of immigration after AD 1310 probably led to high levels of scalar stress, which, in turn, prompted a community-wide organizational response. Two late phase building projects—the enclosure of a large plaza and the construction of an oversized kiva—were interpreted as community-wide efforts to accommodate the new challenges to supra-household decision-making.

Construction of the big kiva and enclosing the plaza area occurred in association with contemporaneous population growth and, thus, may reflect more direct and immediate responses to population change. Both of these architectural changes are viewed as reflecting the need for greater social integration and a reorganization of

the decision-making structure at the site. Both would alter interaction at the level of the entire community, and the community thus appears to have reacted rapidly to changing population levels (Crown and Kohler 1994:114). Too little, too late. Drawing on studies of African villages, Crown and Kohler suggested that all settlements have an optimum residential size, beyond which existing decision-making strategies begin to break down. T'aitöna, it seems, had hit its scalar threshold.

At this point in the growth of a settlement, changes must occur, either through fissioning or restructuring of the population. The abandonment of Pot Creek (T'aitöna) within a decade of the population increase may indicate that the restructuring of interaction with the incorporation of more community integrative structures was not successful (Crown and Kohler 1994:114).

These are reasonable conclusions. To be sure, they are built on functionalist premises, but critiques of functionalism often go too far. Healthy communities do have to find a means of working together; and if T'aitöna, for whatever reason, was becoming overcrowded—if its scale was perceived to be unmanageable—then it is easy to imagine arguments arising that would have led its occupants to either lay down the law (to reorganize “the decision-making structure of the site”) or to jump ship (to “fission”).

Crown and Kohler's study was soon followed by a second consideration of scalar stress at T'aitöna by Wesley Bernardini (1996), who also linked population scale to decision-making and, ultimately, to the abandonment of the village. Bernardini used architectural evidence to argue that as T'aitöna grew over time, it came to include ten residentially distinct clan groupings, each with roughly twenty rooms and 20 adults: all told, a community of 200 or so adults. This “clan-level social organization,” he suggested, began as an effective adaptation to increased community scale, but it was ultimately pushed to its limit during the early fourteenth century, when additional population growth crossed an information-processing threshold and a new supra-clan organization was needed. As in Crown and Kohler's study, the large kiva was read as an ineffective effort to do precisely this:

construction of the large kiva may represent the [villagers'] reaction . . . to the high levels of scalar stress being generated by the 10 clan-level information sources in the decision-making system of the pueblo. The fact that the kiva was never completed and the site was abandoned soon afterwards suggests that this attempt was unsuccessful. (Bernardini 1996:393)

Again, this is a reasonable interpretation, all else being equal. If ten distinct interest groups (clans) were, in fact, all jockeying to have their voices heard in community affairs, this surely would have led to more complicated deliberations than in prior generations, when the scale of decision-making was smaller.

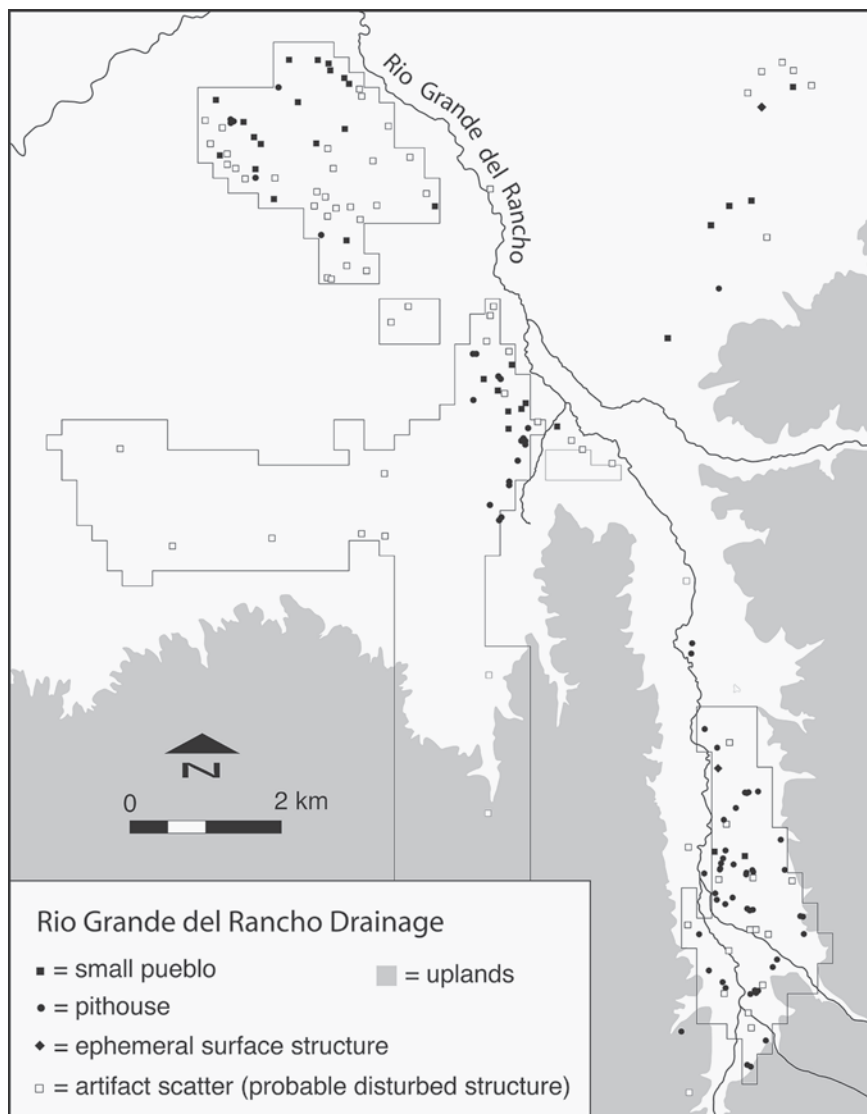
During the 1990s, then, archaeological assessments of T'aitöna's development and demise rested on three core propositions: first, that the scale of the local community reached its maximum in the final years of T'aitöna's occupation; second, that this increased scale may have overtaxed existing organizational strategies, which remained mired at the level of the local residential unit; and third, that the architectural initiatives left incomplete when the village was vacated (*viz.*, the large kiva and the enclosing of a large central plaza) represent aborted attempts to address the growing organizational crisis. As propositions, each was admirably testable, at least insofar as they could be strengthened or weakened through additional excavations, regional survey, and chronological refinements.

THE NEW EVIDENCE

How has another twenty years of research at T'aitöna altered the look of things, then? How have the propositions of the 1990s weathered more recent findings?

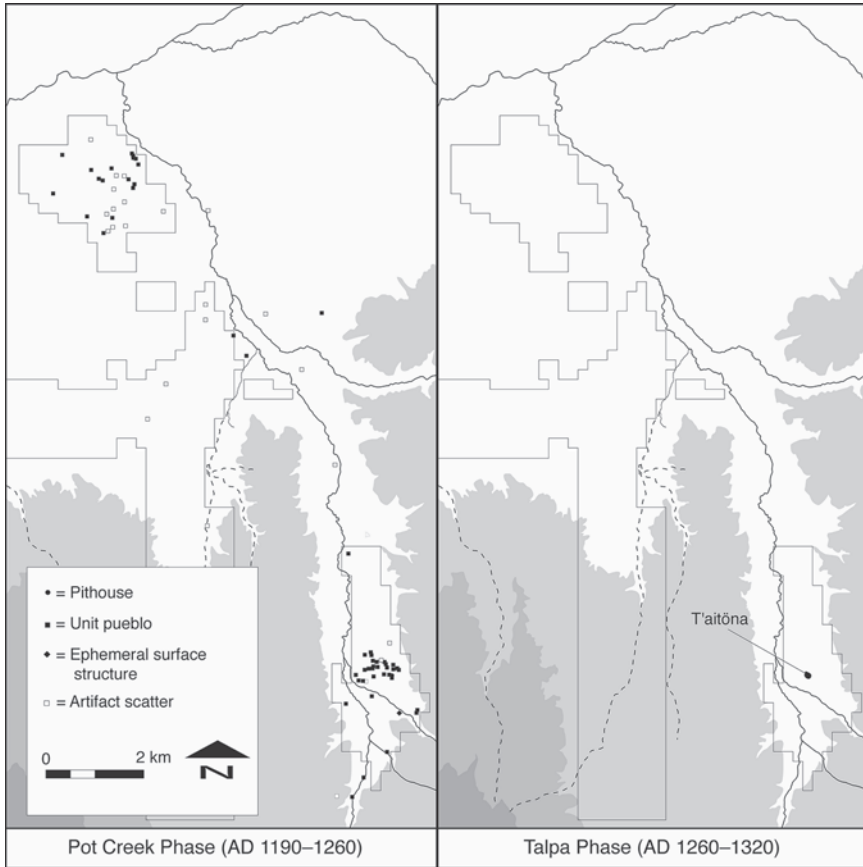
A great deal of additional data has been gathered. New excavations have significantly expanded our understanding of Room Block 6 and have provided an initial sample of living and ceremonial spaces in Room Block 8, the previously untested northwestern portion of the settlement (Adler 2002; Fowles 2004). An ambitious program of surface scraping and mapping under the direction of Michael Adler also resulted in a far more complete picture of the site as a whole, at least as it would have looked at the time of its abandonment (map 11.1). Moreover, additional surveys have established an empirical basis from which to assess population levels and settlement dynamics during the centuries leading up to T'aitöna's occupation (Arbolino 2001; Fowles 2004). Together, this new research directly bears upon the matter of scalar stress modeling in two principle respects.

As would be expected, the number of known rooms for each pre-Columbian period has markedly increased. For instance, we now know of a fourth aggregated village in the Taos district with 100 or more ground-story rooms, most with evidence of additional upper-story rooms. The El Bosque Pueblo¹ (LA 1282, 1283, 1284) is located on the outskirts of the small village of Dixon, a short distance west of Picuris Pueblo. Serious research at the site has only recently begun, but it appears to be one the largest thirteenth-century settlements in the northern Rio Grande and will clearly alter our regional population estimates. Many more settlements dating to the thirteenth century and earlier have also been located in the roughly 180-square-kilometer extent of the Rio Grande del Rancho drainage surrounding T'aitöna, making it possible to rigorously situate the village in a local population history (maps 11.2 and 11.3). We now know of 257 architectural sites dating between AD 1050 and 1320, and elsewhere I have outlined the process by which these data



MAP 11.2. Known Valdez phase (AD 1050–1190) site distribution in the Rio Grande del Rancho drainage.

might be used to estimate population levels for the drainage as a whole (Fowles 2004:appendices D and E). I will not review the details here, except to say that it was necessary (1) to divide the drainage into landscape types based upon available



MAP 11.3. Comparison of Pot Creek phase (AD 1190–1260) and Talpa phase (AD 1260–1320) settlement patterns in the Rio Grande del Rancho drainage.

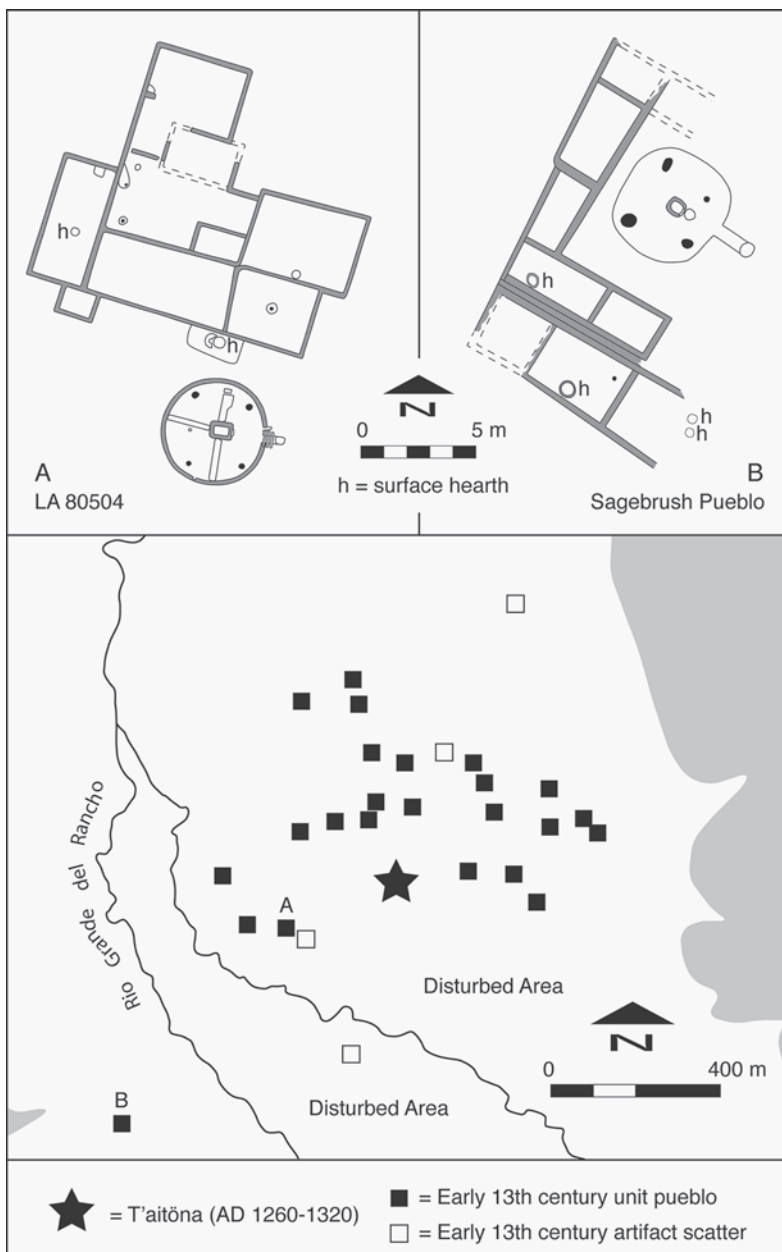
natural resources; (2) to use the density of sites within surveyed portions of each of these landscape types to predict the number of missing sites in unsurveyed or disturbed regions; (3) to correct for the different lifespans and person-to-room ratios at various site types in the study area; and (4) to control for different phase lengths in order to generate estimates of momentary populations in the drainage. Ironically, the resulting regional population estimates may be more dependable than those derived from excavations at T'aitōna, if only because they were generated using predominantly single-component sites, whereas the multigenerational history of building and rebuilding at T'aitōna has clearly hidden much evidence of the village's early occupation.

TABLE 11.1. Comparison of momentary population estimates for the Rio Grande del Rancho drainage, AD 1050–1320 (from Fowles 2004:915)

	<i>Low estimate (families of 4)</i>	<i>Medium estimate (families of 5)</i>	<i>High estimate (families of 6)</i>
Dispersed pithouse settlements (Valdez phase, AD 1050–1190)	310	387	464
Semi-aggregated small pueblos (Pot Creek phase, AD 1190–1260)	467	583	700
Aggregated village (Talpa phase, AD 1260–1320)	352	440	528

We should not place too much faith in the resulting numbers, of course, which only provide a crude sense of the overall population arc through time. Nevertheless, a relatively strong pattern has emerged that directly contests earlier models of a consistent demographic increase from the eleventh century up to the abandonment of T'aitöna. If we set aside the question of intra-site demographic change at T'aitöna itself (which, as I have suggested, remains difficult to assess given both the spatial biases in the existing tree-ring database and the unknown number of early rooms obscured by overlying later rooms) and look at overall trends in the drainage between 1050 and 1320, we discover that the largest local population levels probably *predated* the occupation of T'aitöna. During the Pot Creek phase (AD 1190–1260), in fact, upwards of 700 individuals may have lived in a tight cluster of at least twenty-three unit pueblos² distributed across 40 hectares immediately north of T'aitöna (table 11.1, map 11.4). This semi-aggregated village probably housed more people in the mid-thirteenth century than T'aitöna did at any point during the late thirteenth or early fourteenth centuries.

Here, then, is the first implication of the past twenty years of research: if decision-making stress is to be reckoned in terms of either overall community scale or the number of decision-making units, then it seems to have been greatest during the period just prior to the emergence of T'aitöna as a single architectural complex. The two dozen or so Pot Creek phase unit pueblos immediately north of T'aitöna were all within easy shouting distance of one another. Their occupants would have walked through each other's backyards constantly as they came and went, collecting water from the river, firewood from the hills, or what have you. And yet, there is no evidence of either a site size hierarchy or a large communal structure of the sort that would have served as a decision-making center for the community as a whole. From a scalar stress perspective, this is just the sort of community we would regard as unsustainable, which perhaps explains why a fair number of households appear to have left the valley during the mid-thirteenth century, and why those who remained reorganized themselves into a single, more compact and more formally structured compound: T'aitöna.

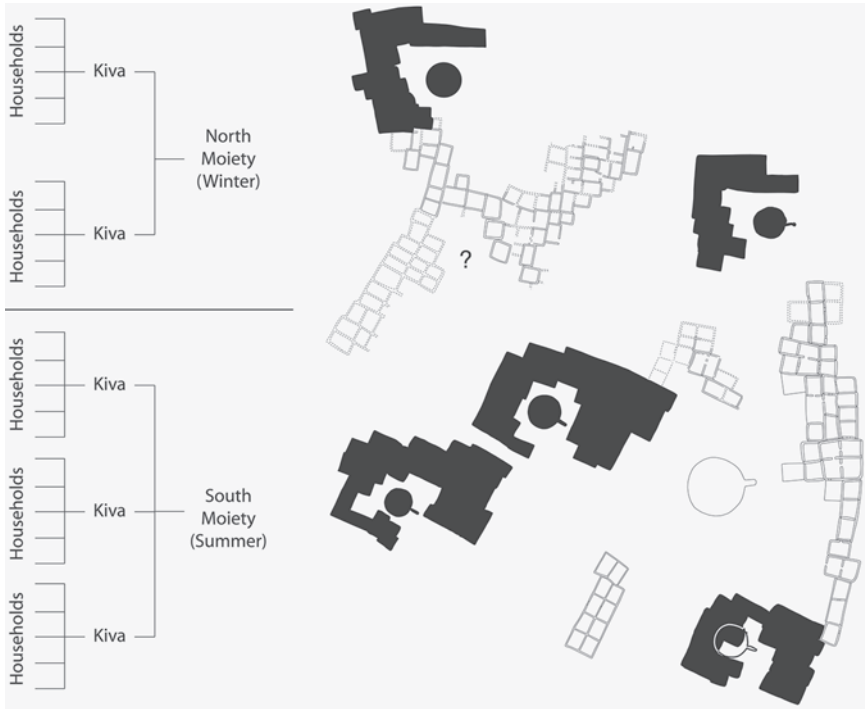


MAP 11.4. The early thirteenth-century (Pot Creek phase) semi-aggregated villages in the Rio Grande del Rancho Valley, including examples of two twenty-three-plus unit pueblos.

I should note that back in the 1990s, few would have described T'aitöna as a "formally structured compound," and this brings us to the second major consequence of recent work at the site: once a relatively comprehensive map of the village architecture was completed, it became clear that T'aitöna had been carefully organized into a dual division from quite early on. Excluding the long lines of rooms constructed during the final decade of the site's occupation (see Crown 1991), T'aitöna emerges as an architectural balance between three C-shaped residential units in the southern half of the site and two L-shaped units in the northern half.³ This difference in room block design was further marked by a difference in architectural orientation. Southern units faced southeast while northern units faced due east (map 11.5), and I have argued that these orientations strongly anticipate the cosmological commitments of descendent Northern Tiwa communities (Fowles 2005). Moreover, structurally opposed north/south shrine constructions, centered on the village, were found to redundantly inscribe the core principle of dualism out into the surrounding landscape (Fowles 2009). The overall pattern suggests, first, that T'aitöna was organized into a community-wide dual division from early on and, second, that this organizational pattern was directly ancestral to the dual division recorded at Taos Pueblo by ethnographers in the late nineteenth and early twentieth centuries.

Needless to say, all of this demands revision to our scalar stress models. Not only was the community smaller at T'aitöna than it had been in the preceding early thirteenth-century occupation; its ten (more or less) residential units were also organized into two macro-groups, which, according to orthodox scalar stress theory, would seem to provide evidence of quite effective decision-making coordination. The long-lived community at Taos Pueblo provides a ready model for how this might have worked, separated as it is by the Rio Pueblo into northside and southside ceremonial groups, with three active kiva sodalities in each. Simply put, there appears to have been plenty of community structure to manage the information-processing demands of the resident community at T'aitöna—with or without the large kiva that was still unfinished when everyone packed their bags and left.

The research questions of the 1980s and 1990s remain before us. We are still interested in developing a robust account of how T'aitöna developed and why it ended. But the priority of scalar stress as an explanatory variable has shifted. It now appears that the village may have been founded as a kind of community solution to the organizational challenges of earlier times. And this leaves us with empty hands when seeking to explain why the village disbanded so abruptly, not only with a large kiva under construction but, as excavations have demonstrated, with extensive supplies of corn still filling many storerooms. If not for want of sufficient organizational structure, then why?



MAP 11.5. A plausible interpretation of the organizational logic of T'aitōna.

THE TRADITIONS OF ALL DEAD GENERATIONS...

Here is where an appreciation of historical identities and the sway of the past in the present becomes so vitally important. Thus far, we have followed in step with traditional scalar stress modeling and treated T'aitōna as so many unit-persons organized into a structure of unit-persons. In this sense we could say that the community, at its peak, probably had a population of between 350 and 530 people divided into two moieties, each of which was composed of between two and five residential room blocks, with a limited group of nuclear family households (probably less than ten) in each room block. A nice sequential hierarchy, it would seem.

The unstated assumption is that the occupants of T'aitōna were all more or less interchangeable with one another. In other words, we have slipped into assuming that there were no Israelis or Palestinians or Republicans or Democrats in the village who would have brought particular historical experiences into the kiva, impeding some negotiations and facilitating others. And it is precisely this fiction that has become increasingly impossible to maintain during the past twenty years.

I have already suggested that new imperatives to engage with the knowledge and concerns of descendant communities have played an influential role in this intellectual shift. Certainly this was the case in my research at T'aitöna. It took an early reprimand from a tribal leader at Taos Pueblo—who quietly but forcefully observed that I was failing to treat the site as the home of “real people”—to push me toward an exploration of T'aitöna's position within specifically Northern Tiwa history. What a surprise to discover that there were indeed indigenous stories passed down about those who had lived at the site (e.g., Espinosa 1936; Gatschet 1892; Parsons 1936, 1996; Stevenson 1906–1907). And how strange to also realize that the academic literature had not engaged these stories. In fact, it is noteworthy that nearly all efforts to incorporate indigenous oral histories into archaeological accounts of the Northern Tiwa past have been undertaken in the context of land claims cases or cultural resource management reports (e.g., Boyer 1997:79–83; Ellis 1974; Ellis and Brody 1964; Greiser et al., as cited in Boyer 1997). The academic literature has surely lagged behind the gray literature in this respect, no doubt because the latter has generally been answerable to tribes in a way that the former, until quite recently, was not.

Be that as it may, the stories reveal a great deal (see Fowles 2004). Some tell of an original population of hunters (the Winter People) who were overcome by a group of ritually powerful agriculturalists (the Summer People) entering the Taos district from the south. Many died in the contest, but when the fighting was over, the father of the Summer People invited the remaining Winter People to come join him as “his children.” Other stories are more specific and break down the histories of these and other groups into a series of movements of named clan-like sodalities. The Day or Shell People (of the Winter People), for instance, are claimed by some to have immigrated to the Taos district from the Chimney Rock-Piedra district, east of Durango in southern Colorado (Ellis and Brody 1964:326). The Feather People (of the Summer People) immigrated from the south, settling first near Ranchos de Taos before being joined at “Blue Earth” (possibly the area still known as Tierra Azul, just north of T'aitöna) by the Water People, the latter of whom had traveled to the region via the Galisteo Basin, the Santa Fe Mountains, and modern-day Peñasco. Taos oral histories further suggest that the Summer, Winter, and Water peoples all briefly lived together at T'aitöna before collectively relocating to Taos Pueblo. I have also been told that the ancestors of *both* Picuris and Taos Pueblos lived at T'aitöna and that a factional dispute among kiva leaders prompted the village to split apart, sending some north to Taos and others south to Picuris.

Additional details might be added (see also Boyer 1997), not all of which can be resolved into a single, internally consistent narrative. This is to be expected, particularly insofar as each kiva society at Taos Pueblo maintains its own stories of the

migrations undertaken by its specific ancestors. The important point is that as soon as we attend to indigenous accounts of the past we are immediately confronted with a congeries of peoples, each with a different history of migrations, each marked by a distinctive accumulation of historical memories comprised of conflicts, confederations, forced relocations, economic reorganizations, ceremonial and linguistic traditions, political successes and defeats, entanglements with regional systems, and more. The growth and decline of a settlement like T'aitōna thus becomes a cosmopolitan story in which it matters a great deal whether the 500 villagers seeking to build a life together were Day People, Feather People, Water People, Shell People, Big Earring People, Stone Knife People, or some mixture thereof.

Once this shift in perspectives has been made, new sorts of archaeological evidence become relevant. Excavations at many sites have demonstrated, for instance, that the final pithouse settlements in the region suffered a strikingly high occurrence of violent death (Fowles 2004:353–72; Green 1976; Whitley 2009). The end of the pithouse occupation (the Valdez phase, AD 1050–1190), in other words, was hardly a neutral phase transition. In some homes individuals were left sprawled on the floor, with skeletal indications of blunt force trauma; in other cases whole families were killed. Decapitation was not uncommon. The outbreak of violence appears to have occurred toward the end of the twelfth century, just as the local population in the drainage began to increase and as new ceramic types (Santa Fe Black-on-white and Smeared Indented Corrugated), architectural traditions (unit pueblos with surface domiciles and kivas), and economies (notably, the first serious commitment to agriculture in the region) were introduced (Fowles 2013). Whether or not we draw upon Taos oral history and interpret all of this as the immigration of the Summer People and their conquest of the Winter People, it is surely the case that two or more communities were in violent conflict and that T'aitōna emerged out of this history of conflict.

The reorganization of the local community during the mid-thirteenth century from a semi-aggregated cluster of small pueblos to a single architectonic complex may mark an effort to bring order to a newly diverse community that was still haunted by its violent past. It is, perhaps, quite significant that half a century had to pass before those living in the Rio Grande del Rancho Valley made the commitment to fully aggregate (or to leave the valley for good, as some appear to have done). By this point most of the villagers who had actually lived through the violence of the late twelfth century would have been deceased. And this may have been necessary for a new generation to commit to a life spent living literally on top of one another.

T'aitōna remained a place where peoples of different backgrounds mixed. This is visible in the ceramics: two technologically distinct but functionally equivalent types of black-on-white pottery persisted throughout the village's occupation, suggesting

the presence of potters trained in different communities of practice (Fowles 2004). The most striking evidence, however, comes from the recent research of Catrina B. Whitley (2009:173–82), who has examined all the human remains excavated at T'aitöna and found clear evidence of two groups of women. One group exhibited pronounced hypertrophy of the deltoid, pectoralis major, and teres major muscle attachments in the upper arms as well as high rates of osteoarthritis where the head of the ribs meets the costal facet; these musculoskeletal stress markers are the signs of many years spent grinding corn. A second group lacked this suite of stress markers, indicating that they were the remains of women who had *not* spent their lives with *mano* in hand (see Whitley 2009:table 5.12). These data are extremely important, for they show us that the women of T'aitöna simply cannot be generalized. Indeed, the daily aches and pains each elderly woman suffered would have served as bodily reminders of a particular history that created common ground with some women and not with others.

It is tempting to also read the strongly bimodal musculoskeletal evidence in terms of an opposition between Winter People and Summer People—all the more so because Taos oral history explicitly discusses the former as traditional hunter-gatherers and the latter as agriculturalists. Life in the village was probably much more complicated than this, however. During her controversial ethnographic work at Taos, Matilda Coxe Stevenson (1906–1907) learned that every kiva was composed of multiple kin groups (“gentes,” as she put it) and that each kin group came to the Taos district via a different route, bringing with them different languages and traditions (see Fowles 2004:appendix A; see also Curtis 1926). At least four small subterranean kivas were constructed at T'aitöna as well as one D-shaped surface kiva. Other subterranean kivas, as yet unexcavated, are surely present at the site. If we use the social organization of historic Taos as a guide, we must imagine that a different kin group managed each of these kivas and that secondary kin groups, perhaps later immigrants, may have been adopted into each as well. That all these different group histories were somehow fitted into an overall north-south moiety organization does not alter the likelihood that the villagers only shared a minimal—and perhaps quite fleeting—sense of communal identity.

Linguistic barriers undoubtedly existed as well. Some families would have brought with them languages and memories from the San Juan Basin. Others had probably spent time on the Plains.⁴ I have argued elsewhere that the Water People may have come to T'aitöna as early participants in an emerging katsina tradition, briefly introducing katsina practices that were quickly contested and locally forbidden (Fowles 2008). In this way, the numerical size of the community may have been less a barrier to effective decision-making than the cacophony of different languages, customs, and traditional claims to power. “Information processing” would

presumably proceed differently in a community where not everyone spoke the same language or recognized the same cosmological authorities.

When I imagine life at the site, however, my thoughts consistently return to the question of what it would have been like to dwell in the historical aftermath of the late twelfth century's outburst of searing violence, when so many perished. Indeed, I readily accept that there is a basic truth to indigenous stories, not just that a violent confrontation between different peoples took place (which seems amply supported by the archaeological evidence) but also that some of the descendants of these opposed groups nevertheless found themselves residing together at T'aitöna and, later, at Taos Pueblo. Grandparents and great-grandparents—still well within social memory—would have been among the perpetrators and victims. The ruins of former sites of violence would have remained highly visible as well. What would it have been like to walk the hills just above T'aitöna and encounter the rotting vigas, broken pots, and scattered ashes of LA 102064, for instance? Here, a family of four met their end in a pithouse—stoned to death, it seems. The body of the father had even been cast upon the central hearth while its fire burned (Green 1976; Fowles 2013:113–19). What stories were told in the presence of such a place fifty or a hundred years later? How did survivors narrate the ruins of their ancestors?

Part of the way archaeologists unwittingly strip real people of their historical consciousness and transform them into interchangeable person-units is by producing maps that present the remains of each time period in isolation from the others, as indeed I have done in maps 11.2 and 11.3. Ostensibly, we do so in the service of clarity: the goal is to unambiguously sort out all the sites produced and used at a particular moment in time so as to better understand how the people of that time dwelt in the landscape. The result, however, is the strange illusion that past communities were blind to their own histories; that they somehow refrained from occupying ruins and other lingering traces of the ancestors with their thoughts and stories; that the Winter People and the Summer People were somehow free of the traumas of the Valdez and Pot Creek phases as soon as their calendars turned a page and entered the Talpa phase. We in the West never live like this. Nor, I am certain, did Pueblo communities.

When we seek explanations for the development and dissolution of a particular community, then, let us bear in mind not just the scale and organization of the population but also the varied histories that would have hung about flesh-and-blood individuals as they struggled to get on together. Something as esoteric as the notion of “decision-making stress” cannot be evaluated using numbers alone. Scale will be fundamentally uninterpretable without some sense of whether the grandparents of those involved had once tried to kill each other.

In the case of T'aitōna, it may well have been that the formal dual division established in the latter half of the thirteenth century was a response to one of those universal truths of scalar modeling: that all else being equal, twenty-three small groups will have a more difficult time making collective decisions than a representative system with six multifamily groups organized into two moieties. But all else never is entirely equal. And if we are to explain why a large kiva was left unfinished at T'aitōna, then I propose it was *not* because the kiva was an attempted organizational cure that simply came too late. On the contrary, I suspect this architectural and deeply political project may have been a lightning rod for dissent. Buildings, like people, have histories, and a large kiva would have introduced a very specific history—broadly speaking, a nonlocal and perhaps even Chacoan history—of authority and power that likely posed a threat to those whose pasts lay elsewhere. Far from being an attempted cure, then, the kiva may have been the very source of decision-making stress. Too many competing histories, in other words, may have been the problem, not too many people. And the fact that the village housed roughly 500 individuals (another favorite magic number for predicting structural transformation, see Graves et al. 1982:117) may have had little, in the end, to do with it.

CONCLUSION

What conclusions, then, might we draw in response to the core demographic questions raised by Jeremy Kulisheck (this volume) as well as the broader epistemological questions raised by Ann F. Ramenofsky and Cynthia L. Herhahn, in their introduction to the volume as a whole?

In the Northern Tiwa case we have considered, much depends on our interpretation of a particular trajectory of relatively short-term population change. As presented in table 11.1, the size of the Ancestral Pueblo community residing in Rio Grande del Rancho drainage effectively rose from nothing at the start of the eleventh century to roughly 400 people during the twelfth century; the population then rose again to perhaps 600 people during the first half of the thirteenth century before declining to about 450 by the start of the fourteenth century. By AD 1320, the drainage was vacated. Needless to say, these are very crude figures in need of refinement, perhaps through new modeling techniques (see Ortman, this volume), but certainly through continued archaeological research focused on (1) the retrieval of a larger number of chronometric dates from dispersed pithouse and unit pueblo sites in the drainage, (2) systematic testing for buried architecture at T'aitōna, and (3) additional survey in the modern communities of Talpa and Ranchos de Taos to determine the effects of recent development on our understanding of

pre-Columbian settlement dynamics. Still, the current population estimates are an empirically grounded starting point.

As Kulishek emphasizes, every population change has a demographic story behind it. Birth and death rates vary in human communities, as do patterns of immigration, emigration, shifting ethnic identifications, and so on. In the case we have been considering, this demographic backdrop is relatively clear. The rapid increase and subsequent decrease of the local community in the Rio Grande del Rancho drainage was surely due, first and foremost, to a complicated sequence of group movements, including both immigration and emigration events. This is evident in the material record, which demonstrates relatively punctuated changes in ceramics, architecture, and settlement placement; and it is also a dominant theme in indigenous accounts of the history of the region. Changing birth rates may have influenced the overall population trajectory, but there is no reason to think this was a driving factor; regardless, we lack a sufficiently representative mortuary assemblage to address fertility. Changing morbidity patterns may have been more significant; certainly, the abundant evidence of traumatic death in late twelfth-century pithouse communities points to a brief decrease in the life expectancy of the autochthonous population. That the overall population nevertheless continued to increase in the early thirteenth century indicates that immigration levels may have been even higher than the numbers superficially suggest.

Population growth via immigration—particularly via relatively abrupt immigration events originating in culturally distinct homelands—has different political consequences than, say, growth via a reduction in birth spacing. Both processes may increase the scale of decision-making and both may lead to new modes of competition, as more individuals seek to build their lives with the finite resources of a local environment. But when a community increases not just in numbers but also in the diversity of its members' historical experiences and when immigration events thrust different cultural traditions into intimate contact, our assessments of the political challenges involved must be recalibrated. Explanations premised on the number of interchangeable person-units must be abandoned and what I have referred to as a "demographics of historical difference" must be undertaken. Which is to say that we must find ways to model all the old wounds, memories of injustice, and inherited prejudices that are the very stuff of political life in cosmopolitan communities like the late pre-Columbian pueblos. Once the raw population scale of a community is pulled apart into the divergent historical identities of its members, we are in a much stronger position to debate the level of potential decision-making stress, as we are to assess why a village like T'aitōna met so abrupt an end.

NOTES

1. Arthur Montgomery, a geologist, briefly recorded El Bosque Pueblo in 1978 as a series of discrete sites, and since then it has been a local secret in the small village of Dixon. More recent work has revealed that it was composed of five main room blocks organized into an east-west dual division on either side of a large arroyo, with an elaborate system of surrounding shrines similar to—but more complex than—the shrine complex surrounding T'aitöna (see Fowles 2009). Santa Fe Black-on-white (B/W) bowls and Smeared Indented Corrugated jars dominate the ceramic assemblage; small amounts of transitional Santa Fe-Wiyo B/W and trace amounts of St. Johns Polychrome are also present. As such, the site was probably occupied for a relatively brief period during the thirteenth century and was, for its time, among the largest villages in the Northern Rio Grande Valley.

2. Each of the twenty-three unit pueblos in this semi-aggregated village appears to contain five to ten surface rooms and a pit structure. Only two have been excavated (see Fowles 2013:372–81). Subsequent construction at T'aitöna and extensive twentieth-century logging have obscured traces of additional Pot Creek phase sites in the vicinity.

3. It is possible that another formal residential unit with a partially enclosed plaza and kiva is present in the area that comprises the intersection of Room Blocks 7, 8, and 9. Future excavations are needed to clarify this issue.

4. There are good reasons for thinking that at least a few individuals from both the Chacoan region to the west and the plains to the east lived at T'aitöna. The D-shaped surface kiva at the site is plausibly a form of Chaco revivalist architecture introduced to the region by immigrant Tewa groups (Fowles 2005). Certain artifacts originating in the Plains have also been recovered at T'aitöna: for example, a red stone elbow pipe, morphologically similar to those occurring at the Antelope Creek sites of the Texas Panhandle; beveled “diamond knives” similar to those of the Republican River Basin of Nebraska and Kansas; turkey tail bifaces fashioned out of exotic raw material; and more (see Fowles 2004:462–70).

Tracking Movement in the American Southwest

DEBORAH L. HUNTLEY

What constitutes evidence of movement? How do we identify it archaeologically in the American Southwest? What kinds of material signatures can we expect people, different kinds of objects, and ideas to leave behind? How can we move beyond the identification of distribution patterns and toward explanations of causality?

These are the difficult questions that the symposium organizers and I posed to participants in the session on long-distance movement in the American Southwest at the 13th Biennial Southwest Symposium. I conceptualized the session as an opportunity for participants to reflect critically on how to identify the intersections of people, objects, and ideas in various case studies of movement in the Southwest. I asked them to strive to develop narratives that moved beyond simply documenting the patterns they observed and to explore causation and explanation.

The topic of movement is one that pervades the prehistoric and historic Southwest and our study of it; “movement” in some form has been prominent in nearly every Southwest Symposium for the past two decades at least (see Nelson and Strawhacker 2011; Hegmon 2000). Archaeologists are skilled at identifying the results of movement—that is, patterns in the distributions of artifacts and features on the landscape. But because behaviors such as migration, exchange, and emulation can produce similar material culture patterns, how do we distinguish among alternative explanations (Carr 1995a, 1995b; Clark 2001; Shepard 1956; Zedeño 1994, 1995, 1998)? Moreover, how can we be sure that we all share the same vocabulary and criteria for tracking and interpreting various kinds of movement?

My goal for this introduction is to provide some context and common terminology for the diverse topics explored by the authors in this section. Below I outline what I think are key aspects of movement, the many variables that come into play in discussing movement, and some of the difficulties in interpreting movement. I also review theoretical and methodological issues that the different chapters in this section have in common and identify possible intersections with the realms of demography and historical ecology also explored in this volume. I view this introduction and the following chapters as a means to stimulate critical thinking about how we study aspects of movement rather than an attempt to develop some unified way of doing so.

Contributors to this section present new research spanning a range of times and places—from the San Juan Basin to the Rio Grande Valley and its tributaries to the late precontact deserts of southwestern New Mexico and southeastern Arizona. All the chapters rely upon multiple lines of evidence at different analytical scales to develop their interpretations. While contributors utilize a variety of analytical tools and employ diverse approaches, they share a focus on the linkages between data and inference as they seek to explain the causes behind the dimensions of movement they document.

DISENTANGLING (?) THE MOVEMENTS OF PEOPLE, OBJECTS, AND IDEAS

Most researchers rely on material culture—objects or non-portable architectural features—to identify movement archaeologically. Obviously, people are at the heart of all kinds of movement: objects and ideas are only “moved” as a result of human activity, although the behavioral processes vary. Disentangling these complex and overlapping behaviors requires a discussion of basic principles for identifying movement as well as the various kinds of movement of people, objects, and ideas.

MOVEMENT, PROVENANCE, AND IDENTITY

Movement has been implicated in identity formation, including ethnogenesis (see Kulisheck, this volume; Eiselt and Darling, this volume), as well as the spread of new ideology and religious practices. Many studies of movement, including those in this section, depend upon being able to identify directly or infer where objects were made. Thus, identifying provenance—place of origin—is necessary before we can explain behavioral processes behind the distributions of objects across the landscape.

Archaeologists employ various types of chemical compositional and mineralogical analysis to establish provenance. Deborah L. Huntley, Jeffery J. Clark, and Mary

F. Ownby, for example, rely upon Neutron Activation Analysis (NAA) (Neff and Glowacki 2002) and petrographic analysis (Peacock 1970) to identify production locations for Roosevelt Red Ware (aka Salado Polychrome) pottery. Similarly, Erik Simpson uses temper (mineral inclusions) and paint characteristics to differentiate unique pottery making traditions in the Upper San Juan and Northern San Juan/Mesa Verde regions during the eighth through thirteenth centuries AD. Jeffrey R. Ferguson and colleagues utilize both NAA of ceramics and X-ray fluorescence (XRF) sourcing of obsidian (Shackley 2005, 2011) to trace the movement of pottery and stone tool material into the Cañada Alamosa study area. Sharon Hull, Frances Joan Mathien, and Mostafa Fayek pioneer a new method of “fingerprinting” turquoise based on variability in isotopic ratios (Hull and Fayek 2013), which they use to document long-distance procurement of this mineral by residents of Chaco Canyon, Aztec Ruins, and Salmon Ruin in the San Juan Basin.

Provenance can also be established indirectly. For example, Simpson’s study of San Juan region pottery traditions exemplifies how archaeologists commonly use technological style (Dietler and Herbich 1998; Lechtman 1977) to differentiate between emulation (movement of ideas) and exchange or population movement. Technological styles are the result of both conscious and unconscious choices made during the manufacture of material culture; they tend to be most apparent in attributes with low physical and contextual visibility or those that require routinized motor habits (Carr 1995a, 1995b; Clark 2001; Lemonnier 1986; Stark et al. 1998). In other words, technological styles tend to reflect cultural knowledge shared by a community of practice (Eckert 2008, 2012; Lave and Wenger 1991; Lyons and Clark 2012; Sassaman and Rudolphi 2001; Stark 2006; chapters in Stark et al. 2008a). Because a community of practice requires regular, face-to-face interaction, outsiders do not easily emulate technological styles.

Communities of practice (social networks in which members share a technological tradition) are crosscut by communities of identity (social networks in which members share a group identity) (Eckert 2012). Group identity, especially as it pertains to ideology or religious practice, may be most apparent in material culture attributes with high physical and contextual visibility (Carr 1995b; Wiessner 1983, 1985; Wobst 1977; but see Ortman and Cameron 2011). As discussed by Patrick D. Lyons and Jeffery J. Clark, high-visibility objects, such as decorated pottery, may be widely circulated because they convey messages about religious or ethnic affiliation (Lyons and Clark 2012:25; Mills 2007). They argue (as do Huntley and colleagues, this volume) that this accounts for the widespread circulation of Roosevelt Red Ware across much of the southern Southwest during the late thirteenth through fifteenth centuries AD. Nonetheless, its widespread production seems closely tied to the Kayenta diaspora. A similar phenomenon may explain why Tularosa

Black-on-white and St. Johns Polychrome vessels were imported into the Cañada Alamosa during the thirteenth century. As Ferguson and colleagues discuss, these vessels may have connected Cañada Alamosa residents with Zuni region villages via new traditions and ritual practices such as feasting.

MOVEMENT OF PEOPLE

In her article on Santa Clara Pueblo perspectives on movement, Tessie Naranjo (1995:247) writes, “Movement is one of the big concepts of Pueblo thought because it is necessary for the perpetuation of life.” While she is referring specifically to Pueblo migration, I believe we can extend this idea to other southwestern peoples and to other types of movement as well. Following David W. Anthony (1990), I define migration as the relatively permanent residential relocation of households or other units from one area to another, usually over a long distance. Often migration traverses social boundaries in addition to geographic or political boundaries (Ortman and Cameron 2011). Migration has long been an important topic in archaeology (Di Peso 1958; Hauray 1958; Lindsay 1987; Mera 1935), although it fell out of favor during the mid-twentieth century. The last several decades have witnessed a resurgence in studies of migration (e.g., Bernardini 2005; Cameron 1995 and others in a special issue of the *Journal of Anthropological Archaeology*; Clark 2001; Duff 2002; Lyons 2003; Eckert 2008; Neuzil 2008; Stone 2003; Woodson 1999) and was a major theme of the 2008 Southwest Symposium (Nelson and Strawhacker 2011). Many of the issues pertaining to migration and population movement discussed in Scott G. Ortman and Catherine M. Cameron’s contribution to that volume are relevant here as well.

Several chapters in this section (Ferguson et al.; Huntley et al.; Simpson) identify long-distance movement that crosses archaeologically defined social boundaries or geographic boundaries. But migration is only one dimension of the movement of people. Other phenomena are seasonal or annual rounds, for example, within established territories. Several of the chapters in this section highlight similar small-scale phenomena, such as shifting settlement patterns as the result of population aggregation or reorganization (Hull et al.; Simpson), or seasonal mobility within a particular region (Ferguson et al.; Simpson). Another thought-provoking example not discussed in this section is small- to medium-scale temporary residential relocation of many Pueblo groups to defensible villages immediately following the Pueblo Revolt of 1680 (Ferguson 2002:36; Liebmann et al. 2005).

In addition, as shown by T. J. Ferguson and E. Richard Hart and others, Ancestral Pueblo people such as the Zuni historically traveled very long distances on a regular basis to places that were important to their economic and religious life (Ferguson

and Hart 1985; Riley 1975; Riley and Manson 1983; Schachner 2011; Snow 1981). Special minerals or pigments not locally available and used for ritual activities (Hull et al. this volume; Solometo 2010; Thomas 2008, 2012; Van Keuren et al. 2013) or economic activities were often the target of such trips. These kinds of movement leave different archaeological signatures than more permanent, long-distance migrations. For example, isotopic studies that allow us to fingerprint southwestern lead ores have shown that, in the late thirteenth through fifteenth centuries, Ancestral Pueblo potters obtained lead ores used to make glaze paints from sources that were often hundreds of kilometers from where they lived (Habicht-Mauche et al. 2000, 2002; Huntley et al. 2007; Huntley et al. 2012). One variable worth further consideration, as I discuss below, is how such procurement was organized.

Periodic pilgrimages and other gatherings such as trade fairs or religious ceremonies are additional potential avenues for long-distance movement. In some cases these events would likely have brought together groups from diverse backgrounds. Examples include pilgrimages to Chaco Canyon and Zuni pilgrimages to Zuni Salt Lake, as discussed by Gregson Schachner (2011), who points out that the sharing of ideas would have been a major part of such pilgrimages. Similar exchanges of ideas and goods likely occurred at large gatherings of Plains groups at the Salinas Pueblos (Baugh 1991; Spielmann 1989) or Pecos Pueblo, or at markets or trade fairs, as discussed by Abbott, Smith, et al. (2007) for the eleventh-century Hohokam. In this section, Hull and colleagues suggest this as one alternative to account for the concentration of turquoise from long-distance sources at Pueblo Bonito in Chaco Canyon. A key question is: How far and under what circumstances can we expect people to travel for such events? How might different kinds of events differ in terms of interactions among groups with different ethnic, linguistic, or other backgrounds?

MOVEMENT OF OBJECTS

People move objects as a result of migration or other population movement; they also exchange them with others. Exchange takes many forms, and a full discussion is beyond the scope of this introduction. Ferguson and colleagues and Hull and colleagues explore various types of exchange in the Cañada Alamosa and the San Juan Basin, respectively. Suffice it to say that different kinds of things—decorated pottery versus obsidian, for example—were likely moved within different networks depending at least in part upon the item's social value. Several chapters in this section (Ferguson et al.; Hull et al.; Huntley et al.) emphasize this phenomenon, which I return to below. It is important to keep in mind that archaeologists are limited, to some extent, in our reliance upon objects in that we are affected by the vagaries of

differential preservation—pots typically preserve better than textiles, for example. As discussed above, compositional studies are key to demonstrating or ruling out exchange, and differentiating various aspects of exchange—such as down-the-line versus direct exchange—requires both distributional and provenance data sets. The chapters in this section bring this point home.

Using architectural data in studies of movement presents a challenge compared with portable objects. While architecture, like portable material culture, embodies technological styles that may be linked to particular social groups, architectural features may be modified over time to an extent not often seen with pottery or stone artifacts. As Ferguson and colleagues (this volume) also point out, architectural styles are constrained to some degree by available construction materials. Despite these factors, both Ferguson and colleagues and Simpson use architectural data to track the movement of various groups of people within their regions of study. In fact, it is the very potential of architecture for modification over time that allows Ferguson and colleagues to identify mixtures of local and nonlocal traditions in the Cañada Alamosa.

MOVEMENT OF IDEAS

Attempting to trace the movement of ideas seems daunting at times, but it also may be one of the more interesting aspects of movement. As discussed above, one possible result of the movement of ideas among different groups of people is emulation. Emulation of a particular design style or iconographic system might reflect the creation or adoption of a new ideology or new religious practices. The same can be said for emulation of particular architectural configurations, such as the association of plazas and rectangular kiva architecture with the spread of the Katsina religion across the western Pueblo region in the fourteenth century AD (Adams 1991).

There are also many possible examples of technological emulation, whereby one group adopts the technology of another, perhaps as innovation. The rapid spread of lead- and copper-based paints used to decorate polychrome pottery, which originated during the late AD 1200s among potters from the Mogollon Rim area of Arizona, is a good example of this phenomenon (Fenn et al. 2006; Herhahn 2006; Huntley 2008). Within the span of a generation, technological knowledge of the raw materials, basic recipe, and firing regime required for glaze paints spread northward and eastward to Zuni, Acoma, and the Rio Grande pueblos. Not all technologies (or technological styles), however, are amenable to emulation. As discussed above, the tendency toward conservatism and the very stability of learning frameworks and communities of practice make some technologies suitable for tracing the movements of certain kinds of material culture with people—for example, through migration (Ferguson et al., this volume; Huntley et al., this volume; Simpson, this volume).

KEY VARIABLES

As each of the section chapters illustrates, there are a number of parameters pertinent to exploring the movement of people, objects, and ideas. Below I outline these as admittedly somewhat simplistic heuristic categories. Again, the goal is not to propose a unified strategy for studying movement but rather to explore common themes and develop a common vocabulary for doing so.

Scale

Scale includes a number of factors, including time (the duration or periodicity of the movement), quantity (the size of the group of people moving or the number of artifacts being moved), and the distances involved. The duration of a particular movement process or event and the number of people or objects involved will partially determine its archaeological visibility. Regarding distance, it is important to remember that we are not just talking about spatial closeness. Social distance does not simply correspond with geographic proximity, as physical distance is mediated in part by a variety of social networks (e.g., see Hill et al. 2015; Mills et al. 2013; Peeples and Haas 2013). Ferguson and colleagues illustrate this in their chapter by the fluctuating directional component of the movement of nonlocal obsidian and pottery into the Cañada Alamosa.

Both Ferguson and colleagues and Simpson successfully examine various types of movement at multiple analytical scales over the long time periods that each study covers. In part because he incorporates demographic data, Simpson is able to compare various scales of population movement that are visible mainly in ceramic technological styles. The first entails immigration from the Northern San Juan/Mesa Verde to the Upper San Juan. The second involves aggregation and small-scale shifts in settlement patterns to the east (upstream) due to environmental changes and conflict. The third is the large-scale, north to south migration during the Gallina phase of the AD 1100s, in which entire communities moved. Simpson argues that population movement and the subsequent mixing of diverse groups culminated in ethnogenesis. Ferguson and colleagues, too, implicate the processes of migration, aggregation, and expansion and the mixing of locals and immigrants in the formation of new identities in the Cañada Alamosa.

Logistics

Logistics refers to the various ways that different kinds of movement could have been organized. For the movement of people, a large body of literature on migration considers organizational parameters (e.g., see Anthony 1990; Mills 2011; Ortman and Cameron 2011). Similarly, there are many ways that exchange and direct procurement of objects and raw materials—not to mention the transmission

of ideas—could have been structured among southwestern societies. The basic organizational units could have been individuals (perhaps defined along gender or age lines), families, entire villages, or some other type of group such as a religious society. Along these lines, Hull and colleagues provide food for thought in their discussion of trade networks versus trade structures. While the former are conceptualized as local connections among communities that may change over time, the latter are more fixed and enduring. Thus, individual communities and their trade networks might be viewed as interchangeable within overall trade structures. Hull and colleagues argue that turquoise procurement in the Southwest constitutes such a trade structure, and the same might be true for other exotic materials with restricted distributions on the landscape.

Returning to the example of lead ores and glaze paints discussed above, my colleagues and I (Huntley et al. 2012) argue that because of the great distances of many ore sources from pottery production loci, acquisition of lead ores was embedded within other procurement strategies. We propose that lead ores were part of a suite of minerals used to create paints for a range of ritually charged objects. Based in part on Pueblo ethnography, we argue further that procurement of lead ores, and possibly control over their distribution, may have been embedded within a ritual mode of production and limited to individuals with particular esoteric knowledge, such as male members of particular religious societies (see also Solometo 2010; Spielmann 2002). This scenario is similar to Hull and colleagues' speculation that itinerant traders or network managers could have organized the procurement and distribution of turquoise from long-distance sources via direct procurement and circulation.

Obsidian is another example of a raw material that is often procured from distant sources and distributed widely. Presumably there were different mechanisms for procurement at various places and times in the Southwest. For example, Clark and colleagues (Clark et al. 2012; Hill et al. 2004) argue that during the fourteenth century, obsidian from the Mule Creek source in the Upper Gila region was circulated throughout the southern Southwest within a network of Kayenta-affiliated groups, who maintained long-distance connections and social ties that cross-cut the traditionally defined Hohokam and Mogollon culture areas. As Huntley and colleagues (this volume) discuss, decorated pottery was also widely circulated within this area—perhaps as part of the same networks, but perhaps part of others. Given the proposed integrative function of Roosevelt Red Ware in a pan-regional ideological movement based on fertility and group well-being, it seems likely that its circulation networks cross-cut obsidian circulation networks. Ferguson and colleagues document similar wide-ranging obsidian circulation patterns that shift through time as social connections change. They also have clear evidence for similar cross-cutting social networks reflected in different material types.

Context

Glaze-decorated pottery, obsidian, and Roosevelt Red Ware provide but a few examples of the significance of context: the nature of use, value, and demand for particular items (see also Mills and Ferguson 2008; Spielmann 1998, 2004). Corrugated cooking jars used in everyday household contexts can be presumed to carry different values than, say, painted bowls or Chaco cylinder jars, and archaeologists typically assume that they were moved in different ways (for a comprehensive review of ceramic circulation in the American Southwest, see Zedeño 1998). The challenge is identifying the value, especially since this may have been situational and changeable. For example, most scholars would probably agree that both painted pottery and obsidian projectile points had significance to the people who made, used, and exchanged them and that this significance accounts in some way for their movement. But the significance might be different for producers and consumers and might change through time and vary from region to region.

Many of the authors in this section recognize the social value of the various materials they use as lines of evidence for movement. For example, the social value of Roosevelt Red Ware, as discussed by Huntley and colleagues, might account for its multiple production locations, widespread distribution, and adherence to particular design conventions (see also Crown 1994; Lyons and Clark 2012). In addition, Hull and colleagues invoke the social value of turquoise in the Southwest as one way to explain its movement over long distances and its concentration in particular archaeological contexts. I wonder also if part of its value might be in the association of this exotic material with a particular distant source and the potential symbolic social or political connotations of this association (Bradley 2000; Helms 1993; Spielmann 2004).

In an interesting contrast in this section, Ferguson and colleagues point out potential differences between the values of obsidian and painted pottery in the Cañada Alamosa. While they acknowledge that the source and physical appearance of obsidian was valued in other parts of the world, they find no evidence that this was true in their study area. They argue that because southwestern obsidian tends to be fairly consistent in color and quality, the source of the material may not have been important to consumers. The visual properties of various types of decorated pottery imported into the Cañada Alamosa, on the other hand, were easily linked to a particular production area and thus signified a significant social connection.

Finally, it is important to recognize that there may be a gendered component to the movement of people, objects, or ideas. The potential role of gender in population movement is perhaps most striking in recent studies of forced migrations, as in the case of captives (Cameron 2011) or refugees (Lowell 2007). While gender is not given explicit attention by any of the authors in this section, I argue that it is

implicit in all studies of movement. Just as the production of material culture may have gendered aspects (Crown 1999, 2001; Crown and Wills 1995; Hays-Gilpin 2000; Hegmon and Trevathan 1996; Mills 2000), so may its distribution.

Additional Considerations

Despite our best efforts, there are a number of factors that may be hampering our study of movement. One factor is the limitations imposed by artificial borders, such as modern state and country lines or the boundaries of archaeologically defined cultures. These are a potential hindrance in that they continue to define, in many ways, the scales at which we are able (or willing) to examine past movements. In addition, connections to historical ecology and demography, in general, have not been well integrated into studies of movement. While most researchers would probably acknowledge that environmental factors can constrain or promote movement, assessing potential environmental causes for population movement, for example, seem to have fallen out of favor among many researchers. Simpson's and Ferguson and colleagues' contributions to this section are notable exceptions in this regard. Demography is especially significant when talking about migration, and I applaud several of the contributors in this section for paying specific attention to demography in their case studies.

Demographic and bioarchaeological data might provide evidence that supplements or contradicts patterns inferred from material culture. The thirteenth-century movement of people from the Northern San Juan to the Northern Rio Grande, as discussed by Ortman and Cameron (2011:236), provides an example of contradictory evidence. Demographic data indicate the Northern San Juan was largely depopulated at the same time that population increased in the Northern Rio Grande, but Northern Rio Grande ceramics and architecture fail to show clear associations with the Northern San Juan. This has led to much debate, with various scholars giving precedence to one or the other line of evidence at the expense of others.

CAUSATION AND EXPLANATION

One of the stated goals of the 2012 Southwest Symposium, and this volume, was to achieve explanations of long-term change. Sorting out patterns in material culture that result from complex, overlapping, and sometimes contradictory types of movement is only one step in this process. Even more challenging is trying to understand the underlying causes behind various types of movement in order to develop explanations for those patterns and overcome the problem of equifinality. As the editors discuss in their introduction to this volume, explanation requires explicit attention to our underlying assumptions about behavioral processes.

By paying attention to scale, logistics, and context, each of the chapters in this section addresses likely causes for the types of movement documented in their particular case studies. Huntley and colleagues attribute migration of Kayenta groups into the Upper Gila and Mimbres regions to the production of Roosevelt Red Ware, but the spread of this ceramic tradition is due to additional factors, including the appeal of new ideology shifting trade networks. Ferguson and colleagues explain some changes in ceramic and architectural styles in the Cañada Alamosa as the result of migration of Colorado Plateau groups, which led to cultural assimilation and hybridization. Other changes, however, are due to short-term regional abandonment and exchange. Simpson attributes the development of a distinctive Upper San Juan identity, as reflected in ceramic and architectural styles, to a combination of migration and demographic shifts. Finally, Hull and colleagues implicate long-distance trade networks and trade fairs in the circulation of valued turquoise minerals into Chaco Canyon and to Aztec and Salmon pueblos.

The very notion of causation, especially if it is equated with intention, may cause some of us to cringe. But, as the chapters in this section illustrate, it is possible to develop “best” explanations among possible alternatives for a given archaeological case study. We can get at some of the *why* questions—not just the *how* questions—particularly if we think critically about how we examine the various movement behaviors we want to study and if we continue to employ rigorous methodologies as we move between data and inference.

Turquoise Trade in the San Juan Basin, AD 900–1280

SHARON HULL, FRANCES JOAN MATHIEN, AND MOSTAFA FAYEK

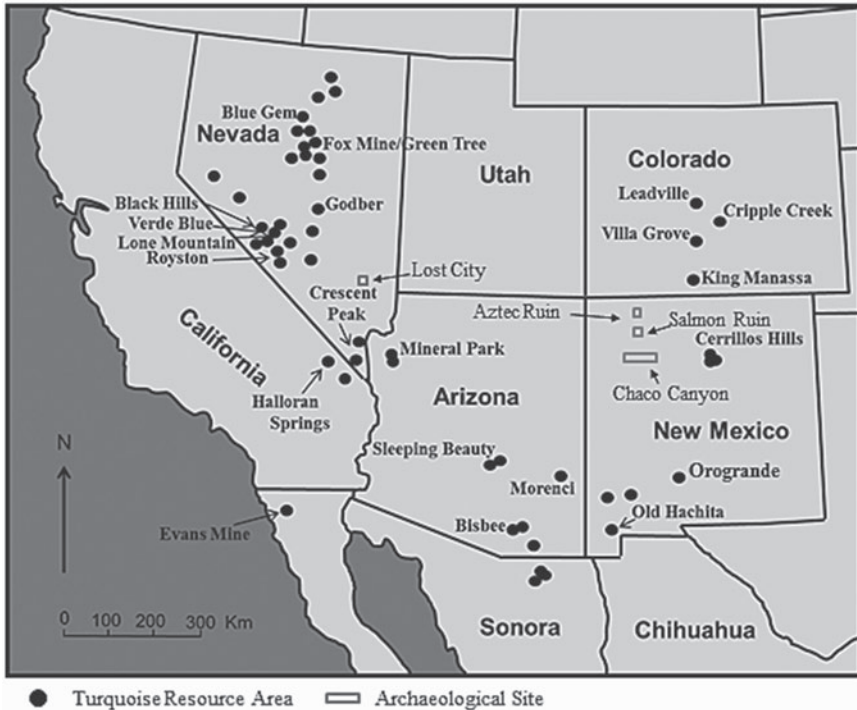
The movement of objects across the landscape is frequently interpreted as an indicator of the movement of people. However, similar patterns in the material culture can be produced by exchange, migration, and emulation (Huntley, this volume). In writing this chapter, we were challenged to explore the causation and explanation for patterns of turquoise procurement strategies that we identified in the Chaco world and how these patterns distinguish the behavioral patterns causal in the movement of objects. We focus on turquoise, a relatively rare and important mineral to the native peoples of the American Southwest. We recently presented data on the analysis of turquoise artifacts from Pueblo Bonito and other small sites near Marcia's Rincon in Chaco Canyon as well as two great house communities in the Northern San Juan Basin: Aztec and Salmon Ruins (Hull et al. 2014). We linked turquoise from the San Juan Basin to deposits in New Mexico, Colorado, Nevada, and the Mojave Desert of southeastern California. We identified distinctive turquoise procurement patterns showing that the samples from Pueblo Bonito and Aztec Ruin shared a similar suite of sources, while the inhabitants from small sites in Marcia's Rincon and Salmon Ruin used different sources. Here we use that data to address (1) the causes and explanation for turquoise procurement patterns in the Chaco world and (2) how these patterns fit into existing migration and emulation models for Chaco Canyon and the Northern San Juan Basin.

Ethnographic studies show that trade and exchange was common between many different pre-Columbian peoples and that the people of the American

Southwest and the Great Basin traveled long distances to obtain exotic resources. These modes of procurement were diverse, including direct acquisition and different types of trade and/or exchange. The terms *trade* and *exchange* are not necessarily interchangeable. Trade, including long-distance movement, down-the-line exchange, and trade fairs, is more businesslike and occurs at a market or some other formal setting; exchange occurs in numerous social settings, including gift giving, tribute, negotiation, coercion, or dowry (Agbe-Davies and Bauer 2010:15; Ford 1983; Hughes and Bennyhoff 1986). Although these modes and types of procurement strategies may have changed through time as social circumstances and environmental conditions fluctuated, it is likely that precontact peoples of the southwestern United States used procurement strategies similar to those described ethnographically.

Investigating procurement of resources and the reconstruction of trade and exchange networks is important when considering the movement of people, as these networks provided avenues for migration and the diffusion of ideas, information, and culture (Urban 2010:208; see Huntley, this volume). Also, the long journeys to trade fairs or to obtain resources through direct acquisition may have brought different groups together and established social relationships that blended diverse culture groups and ideologies. Through these journeys and trade networks, people may have obtained information and developed social ties that may have impacted their decisions regarding relocation. By geochemically linking items of material culture to their geological source, we can begin the reconstruction of these ancient trade and procurement routes, allowing the investigation of possible connections of different groups of people who interacted through these networks.

To link archaeologically recovered turquoise to specific provenance regions, we developed a reliable and replicable technique that identifies unique “fingerprints” for turquoise resource areas by measuring the stable isotopes of hydrogen ($^2\text{H}/^1\text{H}$) and copper ($^{65}\text{Cu}/^{63}\text{Cu}$) using secondary ion mass spectrometry (SIMS). This technique has overcome many of the limitations of trace element analyses of complex minerals, including turquoise, because the geography and geology of turquoise deposits dictate its isotopic composition (Hull 2013; Hull and Fayek 2012; Hull et al. 2008). We developed a comparative database that contains the isotopic fingerprints of twenty-two turquoise deposits in the American Southwest and northern Mexico (map 13.1) to compare the isotope signatures of the unknowns—in this case, the turquoise artifacts. Our technique is relatively nondestructive, allowing the analyzed artifacts to be returned to their original collections.



MAP 13.1. Locations of turquoise resource areas and archaeological sites mentioned in the text.

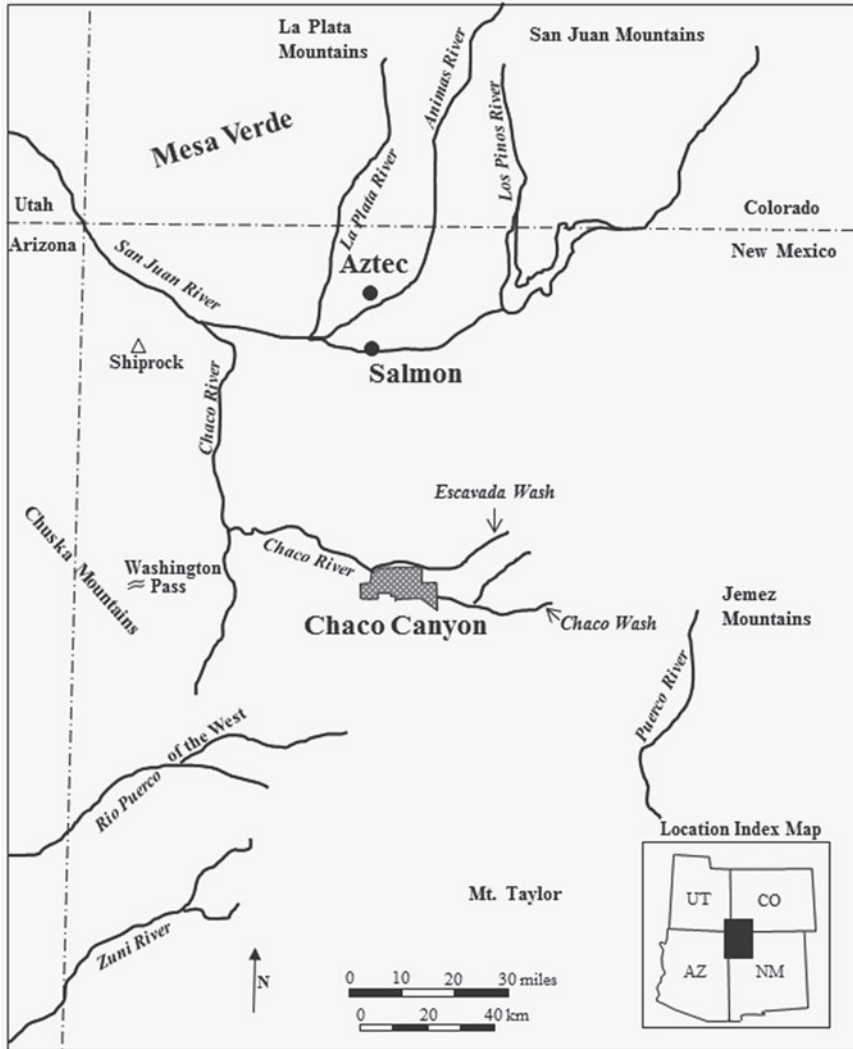
TURQUOISE AND THE AMERICAN SOUTHWEST

Turquoise is one of several blue-green minerals that were used by pre-Columbian North Americans and was a significant symbol of wealth and status. In some cases it was transported over hundreds of kilometers from its point of origin to the archaeological sites where the artifacts were recovered. Turquoise occurs in the semiarid environments of the western United States and northern Mexico. Although turquoise is found in archaic sites, in general, inhabitants of the southwestern United States began to collect and use turquoise and a variety of other blue-green minerals in larger quantity after populations became sedentary, at least seasonally (Jernigan 1978). Ancient miners and artisans collected and used these minerals for various purposes, including the production of jewelry items and pigments. Turquoise was chosen for its color and workability. The mineral turquoise varies in color from almost white to light blue, dark blue and dark green, with all shades in between. With a hardness of 4.5 to 6 on the Mohs scale, turquoise could be made into jewelry using stone tools (Jernigan 1978; Northrop 1975; Pogue 1974).

In principal, it is commonly assumed that the farther a resource or product was moved from its geological provenance, the more it was considered an exotic or luxury item. Considering that over 1 million turquoise pieces were recovered from archaeological sites in Mexico and the American Southwest, the hardships of ancient mining, and the distance between the turquoise deposits and home communities, turquoise must have been as valuable to the early inhabitants of the American Southwest as silver was to the colonial societies of New Spain (Harbottle and Weigand 1992). The development and collapse of many turquoise trade networks must have played out over the centuries within the larger framework of trade structures. Trade structures were organized and continued over long periods of time, providing the background for trade networks that were more fluid and constantly changed through time. Trade networks were local agreements and exchange alliances between communities that came and went within the trade structures (Weigand 1994:27). For example, Chaco Canyon may have been a principal trade center participating in the trade networks within the Greater Southwest, especially in the movement of turquoise. However, when the significance of Chaco Canyon as a trade center declined, the development and importance of another trade center, such as Paquimé after AD 1300, may have filled the void. These changes may have briefly affected trade within the Greater Southwest, but the trade structure endured over time (Weigand 1994:27).

Turquoise has deep roots as a significant component and symbol of Puebloan culture (Snow 1973; Windes 1992) and is ingrained in their cosmology, myth, and ideology (Whiteley 2012:146–50). Contemporary Zuni and Kewa (Santo Domingo) may represent the strongest ties to ancient turquoise mining in the American Southwest. Early accounts of Spanish conquistadors associated the Zuni with the mining and use of turquoise in the early AD 1500s. Early ethnographers also documented that the Zuni traded turquoise and buffalo robes for parrot feathers far to the south using ancient established trade routes that linked them to Native Sonorans (Whiteley 2012:151). These historically identified trade networks may be similar to those that existed among the Ancestral Puebloans, some of whom lived in Chaco Canyon. Historic Puebloan mining of turquoise was documented at the Cerrillos Hills in the mid-1800s, where there is also evidence of extensive and organized prehistoric mining operations (Blake 1858:230).

Located in the approximate center of the San Juan Basin, Chaco Canyon (map 13.2) was an important regional center of the Ancestral Puebloans during the Chaco phenomenon (AD 850–1150; Cameron 2009:1). The canyon contains a large number of archaeological sites along Chaco Wash, including twelve great houses surrounded by smaller habitation sites. Great houses are massive, multistoried masonry structures that typically include kivas (Lekson 1986, 1991:32–36). Turquoise was a highly



MAP 13.2. Location of Chaco Canyon, Aztec, and Salmon sites, San Juan Basin, northwestern New Mexico.

prized mineral and considered an exotic commodity in the economic and religious structures of this ancient culture. Turquoise became so important in the exchange system that it may have developed into currency (Frisbie 1975; Judge 1976, 1989).

Due to its central location in Chaco Canyon and the number of roads leading to it, Pueblo Bonito is the largest great house in the canyon and is considered by some

researchers to be the center of the Chaco world. It has been proposed that an elite group occupied Pueblo Bonito and the small sites in the canyon were habitation sites for the agriculturalists and artisans. Skeletal studies and the amount of elaborate artifacts recovered in Pueblo Bonito compared to those in the canyon's small sites support this model (Akins 1986, 2003; Judd 1954). During excavations at Pueblo Bonito, George H. Pepper (1996) and Neil M. Judd (1954, 1964) recovered thousands of turquoise pieces that included some of the most elaborate artifacts ever recovered in the American Southwest. Turquoise was also recovered from a number of smaller sites, especially at the Spadefoot Toad site in Marcia's Rincon, where debris suggests the manufacture of turquoise ornaments (Mathien 1984, 1993, 2001; Windes 1993), signifying that the elite may have managed the procurement, manufacturing, and exchange of turquoise—not only within the larger region but also over great distances.

During its florescence, Chacoan influence is observed across the San Juan Basin, as many communities constructed great houses, features that may have linked them to the Chacoan culture. Other types of material culture showing Chacoan influence (e.g., ceramics) support strong ties to the canyon. The communities of Aztec and Salmon in the Northern San Juan Basin were considered part of this expansion (Cameron and Toll 2001; Lister and Lister 1987; Reed 2006a). However, around AD 1130 when the population was decreasing in the canyon, the inhabitants of the Aztec and Salmon communities were building (Reed 2006b), along with a corresponding increase in population (Lekson and Cameron 1995). During this time, the center of the Chacoan system in the canyon (Cordell and Gumerman 1989; Lekson and Cameron 1995) was nearing its end, prompting some archaeologists to propose that the elite moved the central power base to the north, as they struggled to maintain their influence across the San Juan Basin (e.g., Lekson 1999, 2006b). Another version of a migration to the north suggests that the inhabitants of Chaco Canyon migrated and colonized these two communities in the Northern San Juan Basin (e.g., Irwin-Williams and Shelley 1980; Lipe 2006; Morris 1915), possibly due to a period of regional drought between AD 1080 and 1100 (Reed 2006c). Salmon Ruin is located on the San Juan River floodplain and Aztec Ruin is near the Animas River (map 13.2). Both would have provided consistent water sources for agriculture during low moisture periods. In contrast, it has been suggested that the Aztec complex was built as a regional center that emulated Chacoan attributes and was in competition with Chaco Canyon (e.g., Van Dyke 2008:335).

The patterns of material culture for migration and emulation are similar and often difficult to distinguish, leading to the development of conflicting models for the expansion in the Northern San Juan Basin. Initial construction at Aztec and Salmon Ruins was similar to the Bonito-style masonry that was associated with the Chacoan period (Reed 2006b). Construction of the Salmon great house was

almost completed by the time there was a shift in the style of construction and ceramics in Chaco Canyon and construction at Aztec Ruin was in its earliest stages (Reed 2006b). It is not clear if Salmon Ruin was only occupied by a Chacoan population or if, as suggested by Paul F. Reed (2008b:18–19), they lived contemporaneously alongside the local San Juan population within the residential core of Salmon Ruin. The inhabitants responsible for Chacoan features at Salmon Ruin around AD 1120 may have relocated to Aztec East shortly thereafter due to flooding of the San Juan River (Reed 2006c). Flood deposits were identified in a kiva at Salmon Ruin that coincides with the proposed time period that the Chacoan population left Salmon Ruin and there was an increase in construction at Aztec East (Reed 2006c). In addition, Salmon Ruin appeared to have been fully occupied by a local San Juan population around AD 1120 (Reed 2006b), much earlier than the records suggest for Aztec Ruin. By the early AD 1200s, artifact and masonry styles at Aztec Ruin changed and were similar to the changes noted at Pueblo Bonito in the late AD 1100s and 1200s. At Salmon, exotic items were identified with the Chacoan population, suggesting that they participated in a long-distance trade network; however, this trade network appears to have declined once the Chacoan population left. There is less evidence of exotic items found in association with the later population at Salmon Ruin (Reed 2006c). Tree-ring dates suggest periods of construction, maintenance, and remodeling at Aztec Ruin (AD 1220–1260) and Salmon Ruin (AD 1257–1263); however, by the late AD 1200s, both pueblos were destroyed by fire and abandoned. It was during this same period that Ancestral Puebloans abandoned entire San Juan and Mesa Verde regions (Reed 2006b).

As the Chacoan culture expanded across the landscape, it is not clear if the building of great house communities and the change in styles was a result of migration of Chaco Canyon residents, local populations emulating the Chacoan culture, or a combination of Chacoan migrants working with local populations (Reed 2011). Chaco Canyon was a unique place in the American Southwest, and local populations may have wanted to be connected to the Chaco phenomenon. As communities became Chacoan, they may have gained prestige, status, and access to the trade networks (Reed 2011). Another consideration includes the possibility of diverse groups (e.g., Pueblo Bonito and Marcia's Rincon) inhabiting Chaco Canyon and that each group may have played different roles in migration episodes to the north.

All three great houses (Pueblo Bonito, Aztec, and Salmon) contained turquoise artifacts and other exotic trade commodities, suggesting that the inhabitants of these communities were connected to extensive trade networks. To identify these networks, the resource areas of turquoise need to be located and fingerprinted and then the isotopic signatures of the artifacts need to be compared to those of the resource areas.

TURQUOISE SOURCING TECHNIQUE

Turquoise is a supergene mineral that forms in the fractures of igneous, sedimentary, and metamorphic rocks by drawing its elemental constituents from the surrounding host rock (Morrissey 1968; Northrop 1975; Pogue 1974). The majority of turquoise deposits are associated with copper porphyry intrusive bodies, including many of the key economic copper deposits in the American Southwest and the Great Basin of Nevada (Anthony et al. 1977; Arrowsmith 1974; Hull 2013; Morrissey 1968; Sigleo 1970). Early attempts to characterize and/or identify turquoise provenance regions relied on comparisons of color and other visual similarities between archaeologically recovered turquoise and turquoise from specific mines. However, turquoise deposits do not have unique colors or visible characteristics that can support a visual method. For example, the color of turquoise can range from light blue to green within a few centimeters in a single sample. Accordingly, the visual identification of sources was unsuccessful and gave way to a number of chemical characterization methods that use trace elements to link source locations and artifacts.

Studies attempting to define trace element composition fingerprints for turquoise provenance regions span four decades and utilize different instruments. They include X-ray fluorescence (XRF) (Judd 1954; Mathien and Olinger 1992; Ronzio and Salmon 1967), inductive neutron activation analysis (INAA) (Bishop 1979; Harbottle and Weigand 1992; Sigleo 1975; Weigand et al. 1977; Weigand and Harbottle 1993), electron microprobe analyses (EMPA) (Ruppert 1982, 1983), atomic emission spectroscopy (AES) (Sigleo 1970), proton induced X-ray emission (PIXE) (Kim et al. 2003), laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) (Zedeño et al. 2005), and examining the mineralogy of turquoise using X-ray diffraction (XRD) (Welch and Triadan 1991). Unfortunately, major and trace element geochemical approaches have also been largely unsuccessful for identifying turquoise provenance due to significant chemical variation within individual turquoise deposits. This variation has repeatedly masked the ability to identify specific provenance regions, regardless of the analytical approach used to measure the chemistry of the turquoise (Harbottle and Weigand 1992; Mathien 1981; Mathien and Olinger 1992; Ruppert 1982, 1983; Sigleo 1970, 1975; Weigand et al. 1977; Weigand and Harbottle 1993). Although not discussed here, there are at least four reasons why elemental analysis of turquoise cannot be used to identify the provenance region of turquoise artifacts: (1) many blue-green minerals are mistaken for turquoise; (2) the complex mineralogy of turquoise affects the trace element composition within a single locale; (3) the geology and formation processes of turquoise deposits are similar between provenance regions, which produce similar trace and rare earth element patterns; and (4) the weathering of turquoise can cause variation in trace and rare earth element concentrations (Hull 2013; Hull and Fayek 2012).

Once the problems with trace element studies were recognized, new approaches were developed. One of the first attempts using isotopic ratios to identify turquoise provenance regions was by Suzanne M. M. Young and colleagues. They measured lead isotope ratios by ICP-MS on several turquoise deposits in Arizona, Colorado, Nevada, New Mexico, and northern Mexico and reported some variation between the mines (Young et al. 1994). Unfortunately, as more turquoise localities were analyzed, the distribution patterns of the turquoise provenance regions began to overlap. Although lead isotope ratios showed only limited success, Young suggested that lead isotope ratios may prove more successful when paired with a second discriminator (Young et al. 1994).

Alyson M. Thibodeau and colleagues paired lead isotope ratios measured by multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) with those of strontium ($^{87}\text{Sr}/^{86}\text{Sr}$) measured by thermal ionization mass spectrometry (TIMS) (Thibodeau et al. 2012). They were able to link turquoise artifacts from a Hohokam Village (Redtail site) with turquoise provenance samples from the Silver Bell Mountains and a nearby village (Scorpion Village). Although the technique shows promise because it is not affected by turquoise alteration (Thibodeau et al. 2012), the samples are completely destroyed during sample preparation.

Using hydrogen and copper isotope ratios and the microanalytical abilities of SIMS, we have been successful in defining turquoise resource areas (Hull 2013; Hull and Fayek 2012; Hull et al. 2008; Hull et al. 2014). The advantages of this technique are (1) isotope ratios of turquoise are geographically distinct and thus overcome the limitations of trace element analyses; (2) *in situ* micro analysis avoids inclusions of other minerals, which could profoundly affect the trace element and isotopic composition of turquoise; and (3) except for minor polishing of the surface of artifacts and 50-micrometer-diameter pits that are created during analysis, turquoise artifacts remain relatively undamaged.

There are three essential points to consider with regard to provenance studies of any archaeological material: (1) the data obtained will only be as good as the reference database used for comparison (Lee 2004:302); (2) the research will always be a work in progress; and (3) additional limitations may be identified as more samples are tested (e.g., turquoise alteration: Abdu et al. 2011; Hull 2006). Therefore, we established a comparative database that contains twenty-two turquoise resource areas representing deposits in Arizona, Baja California, southeastern California, Colorado, Nevada, and New Mexico (Hull 2013; Hull et al. 2014) and maintain a digital archive of the data obtained from all analyzed turquoise samples. For some of the turquoise resource areas, we analyzed multiple samples from different locations within a single locale and many of the provenance samples were analyzed several times over a two-year period to test for reproducibility (Hull 2013). We continue

to add turquoise resource areas to the comparative database as provenance samples become available, with the data from every analyzed turquoise artifact maintained in the digital archive. As the isotopic signatures of newly analyzed turquoise resource areas are added to the database, it is possible that some of them may overlap with existing distribution patterns. The data from turquoise artifacts previously analyzed are reviewed as more turquoise resource areas are isotopically characterized.

TURQUOISE PROCUREMENT PATTERNS AMONG THE COMMUNITIES OF THE SAN JUAN BASIN

Although geochemical provenance techniques are an excellent tool to identify the geological source of *where* a resource was originally obtained, these data must be used in conjunction with other archaeological evidence to enhance our understanding of the behavioral processes of *how* (e.g., exchange, trade, or direct acquisition) and *why* (the use and meaning to the end user) a resource was obtained. However, by linking the geological sources (point A) of archaeological materials with the site where the archaeological material was recovered (point B), we can (1) compare this data to current trade and exchange hypotheses and models; (2) investigate the relationship of the archaeological site and the resource area; and (3) point to relationships among communities that show similar procurement strategies. Here we discuss the turquoise procurement patterns we identified and the inferences deduced from our data that we use to compare with current models of migration and emulation. We then follow with a discussion of causation and explanation for the procurement strategies of the Chaco world.

Table 13.1 summarizes the sourced turquoise pieces by provenance area. Of the thirty turquoise artifacts analyzed from Pueblo Bonito that date from the mid AD 900s to 1200, nineteen were recovered from Room 33, one of four rooms used as a burial repository by one of the elite lineages (Akins 1986). Sixteen of the nineteen artifacts were associated with two burials (burials 13 and 14) that were recovered beneath the floor and have been dated from AD 900 to 1000 (Coltrain et al. 2007). The three artifacts from Room 33 recovered from above the floor where additional burials from this lineage were found date from AD 1000 to 1100. The other ten artifacts from Pueblo Bonito were recovered from seven other rooms throughout the pueblo. Seven of the turquoise artifacts from Pueblo Bonito were linked to the Cerrillos Hills Mining District and one to Orogrande in New Mexico. Five fell into the distribution patterns of the Villa Grove Mine, located in the northern end of the San Luis Valley in south central Colorado (Hull et al. 2014:192, table 2). All three of these turquoise resource areas are located along or near the Rio Grande Rift. Four artifact samples were linked to deposits in Nevada: three artifacts (one each

TABLE 13.1. Summary of provenance areas of turquoise artifacts analyzed by site/time period

<i>Sites</i>	<i>Geological Source Areas</i>						<i>Total by site and time</i>
	<i>Cerrillos Hills, New Mexico</i>	<i>Orogrande, New Mexico</i>	<i>Colorado</i>	<i>Central Nevada</i>	<i>Nevada, Arizona, California</i>	<i>Unidentified sources</i>	
Pueblo Bonito pre-1000	5	1	4	0	0	8	
Pueblo Bonito post-1000	2	0	4	1	1	4	
Pueblo Bonito Total							30
Aztec 1000–1280	1	2	5	0	1	5	14
Salmon 1125–1280	0	0	0	1	2	5	8
Small sites pre-1000	0	0	0	3	0	2	
Small sites post-1000	0	0	0	3	0	1	
Small sites Total							9
Total	8	3	13	8	4	25	61

from Room 26, Room 28, and Room 33) with Crescent Peak, near Searchlight, and one artifact (Room 85) with Lone Mountain, north of Las Vegas. The one artifact recovered from Room 33 that linked to the Crescent Peak deposit is associated with dates ranging from AD 900 to 1000. The other three artifacts are associated with dates of AD 1100 to 1200 and after 1060, respectively. Twelve turquoise samples did not plot in to the distribution patterns of any of the turquoise provenance regions that are included in our database and are referred to as unknowns or unidentified. These unidentified artifacts may be linked to deposits in the future as additional turquoise resource areas are isotopically characterized and added to the database. Based on these results, the identified turquoise resource areas used by the inhabitants of Pueblo Bonito are predominately located along the Rio Grande Rift, and this pattern was consistent over three centuries.

Nine turquoise artifacts associated with dates ranging from the AD 600s to the 1200s were analyzed from five small sites that cluster in Marcia's Rincon (29SJ625—Three C site, 29SJ627, 29SJ628, 29SJ629—Spadefoot Toad site, and

29SJ633—Eleventh Hour site), located on the south side of Chaco Canyon near Fajada Butte. The turquoise provenance pattern of these small sites was notably different from Pueblo Bonito's pattern. Out of the nine turquoise artifacts from the small sites, five artifacts were linked to the Royston Mining District and one to Lone Mountain. Both turquoise resource areas are within the same turquoise provenance region north of Las Vegas, Nevada (map 13.1). These data suggest that the inhabitants of the communities in Marcia's Rincon participated in a long-distance network linking them to the turquoise resource areas in central Nevada that lasted for almost five centuries. The geological source of three of the samples was not identified. It is notable that none of the turquoise was linked to the resource areas along the Rio Grande Rift, in contrast to the majority of the turquoise from Pueblo Bonito. This pattern suggests diverse turquoise procurement strategies between a great house community and the small sites in Chaco Canyon.

Fourteen turquoise artifacts were analyzed from Aztec Ruin. Five of these artifacts were associated with dates ranging from AD 1000 to 1280 (Room N15), two with dates from AD 1100 to 1280 (Rooms N65 and S9), and six artifacts with dates ranging from AD 1200 to 1280 (four that were associated with burial 25 in Room N111 and two associated with burial 14 in Room E52). One turquoise artifact sourced to the Cerrillos Hills, two to Orogrande, and three to Colorado resource areas—Cripple Creek, King Manassa, and Villa Grove. One artifact sourced to Crescent Peak and one to Halloran Springs in southeastern California's Mojave Desert. Five artifacts did not source to the turquoise resources in our comparative database. This turquoise procurement pattern is more similar to that of Pueblo Bonito than the small sites in Chaco Canyon.

The samples from Salmon Ruin are associated with dates ranging from AD 1125 to 1280; all eight of the turquoise artifacts were recovered from the later occupation that Reed refers to as the San Juan population (Reed 2006c). Five of the turquoise samples did not plot within any of the characterized distribution patterns of the turquoise provenance regions. The turquoise provenance regions identified for the remaining three were Crescent Peak and Blue Gem in Nevada and Halloran Springs. The turquoise procurement pattern for Salmon Ruin is intriguingly similar to the pattern from the small sites in Chaco Canyon, suggesting that the inhabitants of these sites may have been connected to a long-distance trade network that extended as far as Nevada and southeastern California (map 13.1).

Pueblo Bonito's turquoise procurement pattern appears very different from the pattern of the small sites represented in this study. The monumental size and craftsmanship of Pueblo Bonito's architecture, the quantity of exotic and ceremonial artifacts recovered, and skeletal studies suggest that an elite population resided in the pueblo, while the inhabitants of the small sites were agriculturists and artisans

(Akins 1986, 2003; Judd 1954). Our data supports this model, showing a difference in the practices of the inhabitants of the five small sites in the canyon for obtaining turquoise when compared to the practices by the inhabitants of Pueblo Bonito. It has also been suggested that the inhabitants of small sites may have been the suppliers and artisans who procured turquoise and other blue-green minerals and were responsible for working these stones into finished items (Lewis 2002). However, they may not have been the ones who used them in ceremonies; this function may have been reserved for the elite leaders in the great houses. The presence of an artifact from 29SJ627 that was sourced to Lone Mountain, as well as one artifact from Room 85 at Pueblo Bonito, could support this model. However, no turquoise sources to Colorado or New Mexico resource areas at any of the sites in Marcia's Rincon. Unfortunately, our data set is currently too small to establish robust patterns. Although the number of artifacts we analyzed from Chaco Canyon is small, especially when thousands were recovered during excavations, we have assumed they are representative of differences in procurement/trade patterns among the communities because our samples span several hundred years and include an overlap in periods of occupation. The sample sizes from Aztec and Salmon Ruins are also small. Nevertheless, these data are helpful in establishing the direction for future studies.

The similar turquoise procurement patterns between Pueblo Bonito and Aztec Ruin are distinctively different from the patterns from Salmon Ruin and the small sites in Chaco Canyon. The most notable difference is the absence of the use of turquoise resource areas along the Rio Grande Rift by the inhabitants of Salmon and the small sites. A study of discrete dental traits also suggested that the population from Pueblo Bonito was more closely related to the population at Aztec Ruin when compared to the skeletal samples from Salmon Ruin (Durand et al. 2010). It is important to note that the turquoise artifact samples and the skeletal remains used in the study of discrete dental traits were from the San Juan population (often referred to as the secondary occupation) at Salmon Ruin and not the Chacoan occupation. Our data from the artifacts associated with the later occupation would support the model that a local population occupied Salmon Ruin (Reed 2011). Unfortunately, we do not have information from artifacts that were associated with the proposed early Chacoan occupation.

The long-term continuity for the use of turquoise sources in Room 33 of Pueblo Bonito and those from Aztec (sources from Colorado and New Mexico) support models that include a migration of a Chacoan population, most likely the elite, to Aztec Ruin (e.g., Irwin-Williams and Shelley 1980; Lekson 1999, 2006b; Lipe 2006; Morris 1915). Several hypotheses may account for the similarities in the patterns of Pueblo Bonito and Aztec Ruin, including (1) connection to similar trade networks,

(2) knowledge and access to the resource areas in Colorado and New Mexico, and (3) migrants to Aztec carrying turquoise from Pueblo Bonito, especially if the turquoise was for important ceremonies. The similarities among the procurement patterns of the small sites in Marcia's Rincon and the San Juan population at Salmon Ruin suggest a link between these people. Although we identified some similar patterns among the communities, it is important to consider that, as the Chacoans moved north and lived alongside the local population sharing skills and knowledge, both populations may have developed new social identities (Reed 2011).

CAUSE AND EXPLANATION

Because our data set is small, we have examined our results in the context of existing migration and emulation models in the Northern San Juan Basin. When used in conjunction with other data and models, we can begin to explore cause and explanation, building a model that can be tested and improved. Cause and explanation addresses how and why questions (see Ramenofsky and Herhahn, this volume), and in this chapter we are primarily concerned with how. Turquoise was obtained because it was important to the Ancestral Puebloans. It was a luxury item—important for the show of status and a significant symbol of their ideation. The *how* focuses on the procurement strategies of the communities that obtained the turquoise. Based on our results, turquoise was acquired from different resource areas throughout the western United States (map 13.1) through the use of long-distance trade networks, trade fairs, or direct acquisition. The latter would have involved organized mining expeditions.

Direct acquisition of turquoise from the Cerrillos Hills has been postulated. Beginning with Pepper, who first reported on the thousands of turquoise artifacts recovered from Pueblo Bonito in the early 1900s (Pepper 1996), and evidence documenting extensive and organized pre-Columbian mining of turquoise at Mount Chalchihuitl in the Cerrillos Hills (Blake 1858; Silliman 1881), archaeologists have suggested this resource area as the nearest and most probable source of turquoise for Chaco Canyon (map 13.1). Unfortunately, definitive evidence for the presence of Chacoan miners at the Cerrillos Hills Mining District generally, or Mount Chalchihuitl in particular, is lacking. The sourcing data, however, is unambiguous evidence of Chacoan exploitation of the Cerrillos Hill sources.

Our analysis also suggests that Orogrande and several of the Colorado resource areas were exploited. Although the data are currently lacking to establish whether turquoise was obtained directly or through trade, it would not have been difficult to follow the Rio Grande Rift south to Orogrande and north to the Colorado deposits, if mining expeditions and camps were established in the Cerrillos Hills area.

Our study shows that the Ancestral Puebloans of the San Juan Basin also obtained turquoise from provenance regions in Nevada (Crescent Peak, Royston Hills, Lone Mountain, and Blue Gem), and Halloran Springs in California (map 13.1). Considering the distance and other culture areas between the basin and the resource areas, it is more likely that the turquoise was procured through long-distance trade networks. Long-distance trade routes—with the flow of shell, salt, and turquoise moving from western resource areas (e.g., California and Nevada) into areas such as the river valleys of the Salt and Gila Rivers in Arizona or the San Juan Basin of northwestern New Mexico—have been previously proposed and investigated by researchers (e.g., Harbottle and Weigand 1992; Hull et al. 2014; Lyneis 1986; Rafferty 1990; Roberts and Ahlstrom 2012; Sigleo 1975; Weigand and Harbottle 1993). The Virgin River branch of the Ancestral Puebloans inhabited areas in southern Nevada, northern Arizona, and parts of southern Utah and may have been an important component of the long-distance trade routes (Ahlstrom and Roberts 2008:130; Roberts and Ahlstrom 2012). There were several communities located in the Moapa and Virgin River Valleys, north and northeast of the city of Las Vegas, and possibly some small sites in the Las Vegas Valley, where the present-day city of Las Vegas is located (Roberts and Ahlstrom 2012). One of the largest settlements was Lost City, also known as Pueblo Grande de Nevada, located in the Moapa Valley (map 13.1). Kevin Rafferty (1990) proposed that the inhabitants of Lost City were exploiting turquoise from Halloran Springs, Crescent Peak, and the Sullivan Mine near Boulder City, Nevada.

As detailed in ethnographic studies of the Great Basin (Hughes and Bennyhoff 1986) and the American Southwest (Ford 1983), trade fairs were an important means for moving materials and ideas. We concur and suggest that these fairs explain a great proportion of pre-Columbian trade and exchange (Janetski 2002:347). Although simple down-the-line trade occurred between individuals or small groups in the Great Basin, most trade occurred at these organized events (Hughes and Bennyhoff 1986). Trade fairs were prescheduled and organized and included feasting, gaming, bartering, social interaction, and rituals. These periodic gatherings must have played a significant role in bringing diverse peoples and commodities together in the pre-Columbian Greater Southwest. Historic accounts report that trade fairs held at Taos and Pecos included the Puebloan peoples and other nomadic groups, including the Comanche and Apache.

Ancient long-distance trade networks and trade fairs were an important avenue for the movement of goods, but they also served other purposes. Information about distant regions would have traveled along these networks, providing ideas and possible options for migration (Duff 1998:33). They were also avenues of social interaction (Irwin-Williams 1977:142) that could blend diverse social, political, ritual,

and economic systems. Early European explorers reported an impressive amount of trade in the American Southwest and the long distances that were traveled by foot (Ford 1983:712). Nomadic groups were also reported as bringing items to regional centers (e.g., Pecos and Taos) for trade (Ford 1983:712). Scheduled trade fairs would have been a means that brought both sedentary and mobile populations into close and perhaps continuous contact. The mechanisms responsible for the movement of turquoise across the American Southwest were probably as diverse as the cultural groups that lived there.

CONCLUSION

Our ability to identify the geological sources of turquoise artifacts and patterns of procurement strategies of sites in Chaco Canyon, Aztec Ruin, and Salmon Ruin adds support to existing migration and emulation models in the San Juan Basin. We showed distinct patterns of turquoise procurement between Pueblo Bonito and the small sites in Marcia's Rincon, suggesting multiple networks in the canyon that linked separate populations (Akins 1986, 2003; Judd 1954). Similar patterns in turquoise sources between Pueblo Bonito and Aztec Ruin support a link between these two communities. We also identified similar turquoise source patterns between the small sites in Marcia's Rincon and the latter occupation at Salmon Ruin. How the turquoise was moved from its geological source to the archaeological site where it was used needs to be examined in context with other data. Our data indicates that turquoise from the San Juan Basin links to turquoise deposits in New Mexico, Colorado, Nevada, and southeastern California, suggesting that at least some of the turquoise was moved over long-distance trade networks.

Throughout the American Southwest, modes of resource procurement were diverse—including regional trade centers, trade fairs, seasonal migrations, organized expeditions, and traveling merchants—fluctuating through time as circumstances changed. As objects were traded or exchanged, social bonds developed that may have become more cohesive through time (Bauer and Agbe-Davies 2010; Urban 2010). The trade routes would have provided avenues for the flow of ideas and information, and the growth of relationships between diverse groups of people may have provided avenues for migration. Social relationships developed with distant peoples along these trade networks, and information on distant landscapes would have presented opportunities for possible migration destinations.

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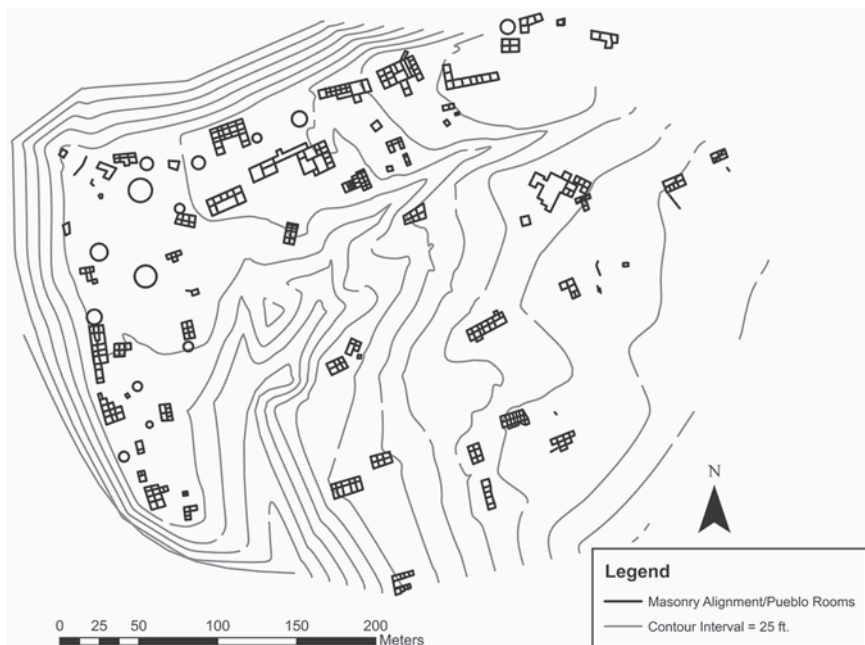
You Get It Here, I'll Get It There

Examining the Movement of Objects, People, and Ideas throughout the Pithouse and Pueblo Occupation of the Cañada Alamosa

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The Cañada Alamosa contains a 700-year sequence of pithouse and pueblo occupation associated with material culture from surrounding regions that shift through time. We propose that the Cañada Alamosa was not home to a stable population that simply switched to different sources of obsidian and ceramics through time but, instead, was composed of a dynamic mix of local people and immigrants. Each group faced different situations and established connections that were, in turn, affected by changes in the structure of surrounding populations. We demonstrate these shifts by examining different lines of material evidence and propose narratives for different scales of regional interaction, exchange, and population movement (Huntley, this volume). The movement suggested by these data includes short- and long-distance exchange and outright migration of specific groups as well as subsistence-driven expansions and contractions of population. Each of these processes of movement involved interaction among multiple groups that sometimes, but not always, resulted in assimilation and hybridization.

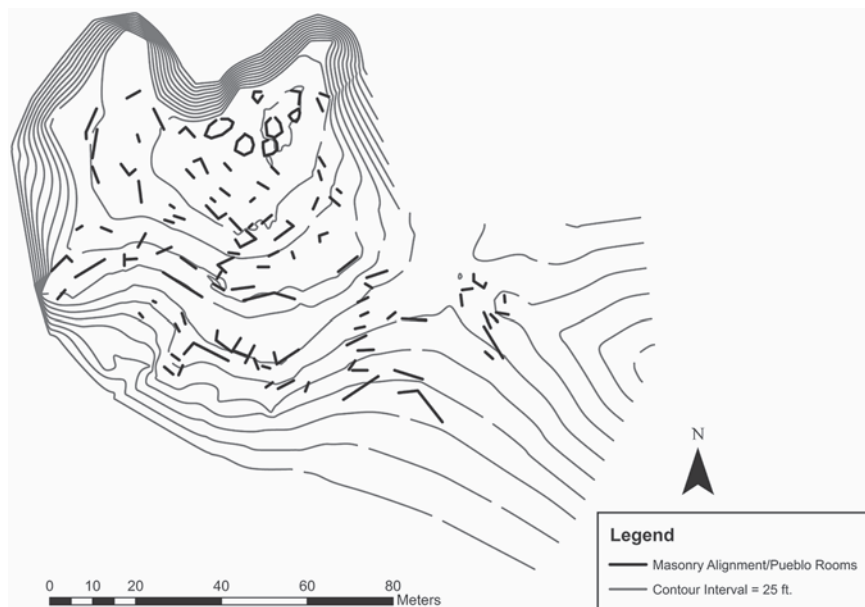
The Cañada Alamosa Project (CAP) is located along the Rio Alamosa, a 728-square-mile watershed that empties into the Rio Grande just north of Truth or Consequences, New Mexico. The Rio Alamosa provides a perennial water source to the four sites in this study that occupy a short stretch of the canyon, with low terraces suitable for farming. From 1999 to 2011, CAP systematically tested these sites. They are all within a one-mile stretch of the Rio Alamosa and their occupation spans the time period from circa AD 700 to 1400.



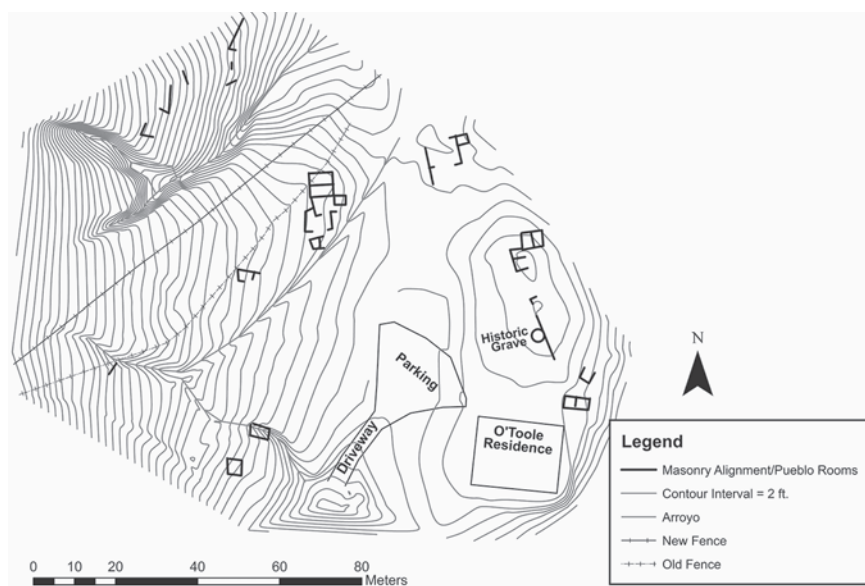
MAP 14.1. Victorio site, LA 88889.

The Cañada Alamosa is a rugged canyon fed by a perennial warm-water spring that produces approximately 2,000 gallons per minute. Agriculture was limited to dryland farming on the slopes and terraces and the possibility of ditch irrigation in the wider areas of the river bottom. The four sites are clustered in an area that is enhanced by a subirrigated area, or *cienega* (maps 14.1, 14.2, 14.3, 14.4).

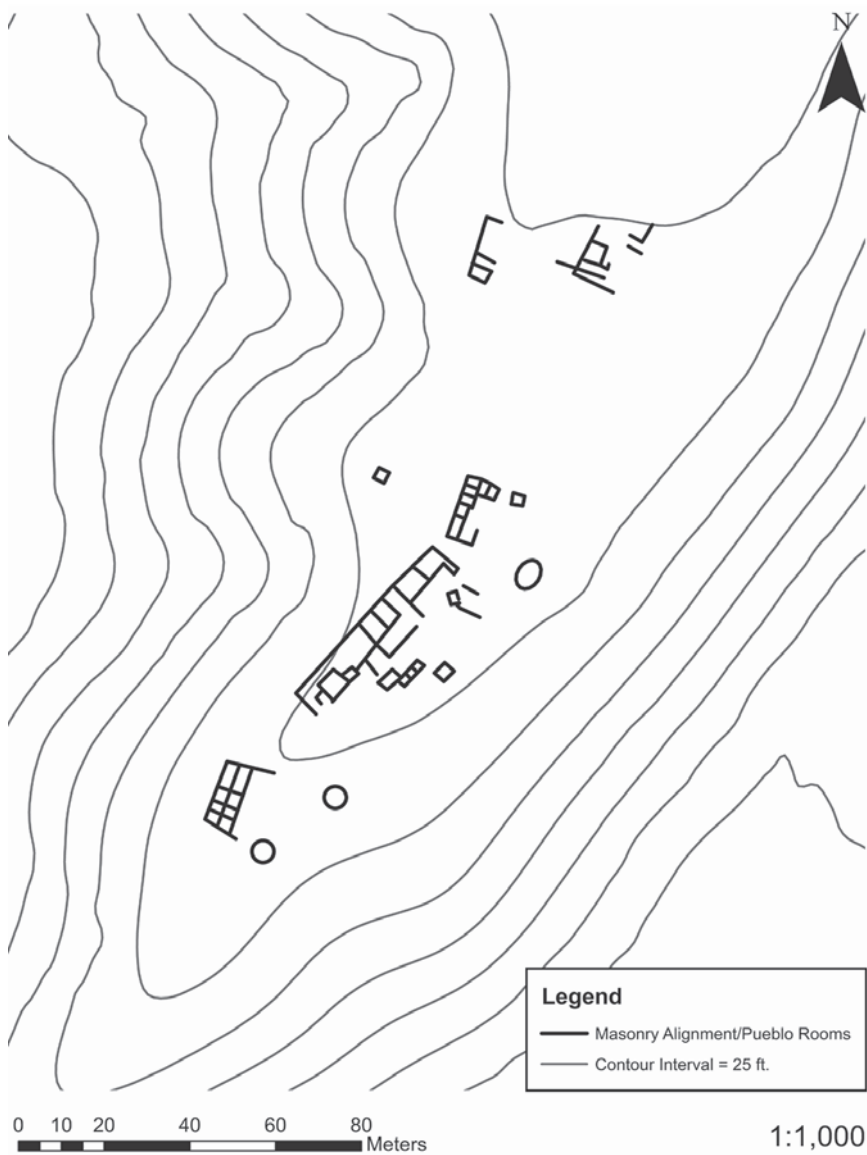
The sequence of material culture represented by these sites begins with the Middle and Late Pithouse periods (AD 700–900; Victorio site) that are followed in time by components representing the Mimbres phase (AD 1000–1130; Montoya and Victorio sites), the Socorro phase (AD 1130–1200; Kelly Canyon, Montoya, and Victorio sites), the Tularosa phase (AD 1200–1290; Victorio site), the Magdalena phase (AD 1240–1290; Pinnacle Ruin), and Glaze A (Early Classic, AD 1300–1400; Pinnacle Ruin). In general, southern wares and architectural styles dominate the earlier components (Pithouse through Mimbres phases), while northern wares and architectural styles dominate the later components (Socorro phase through Glaze A). The 700-year sequence of excavated material reflects a consistent and dynamic interchange of material culture from and through the equally dynamic Mogollon, Cibola, and San Juan culture areas (maps 14.5, 14.6, 14.7, 14.8). It is important to



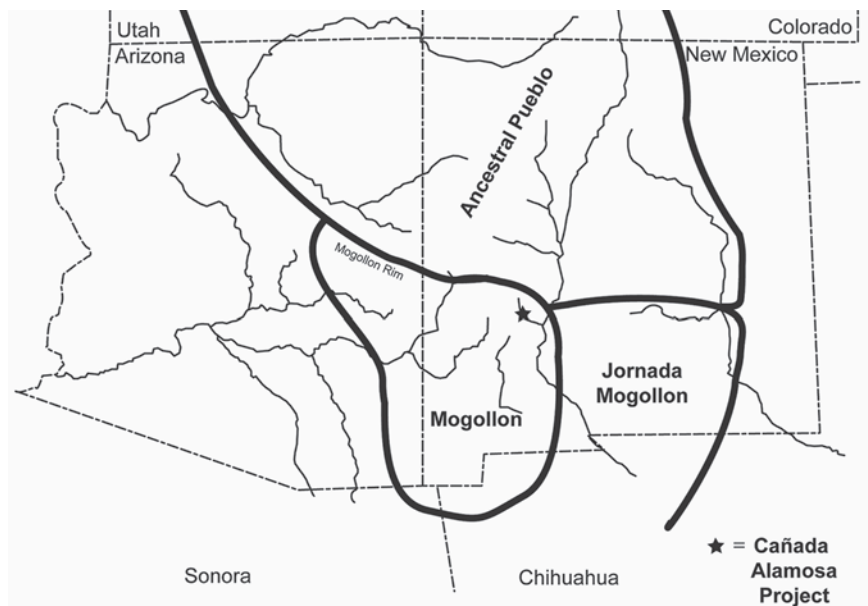
MAP 14.2. Pinnacle site, LA 2292.



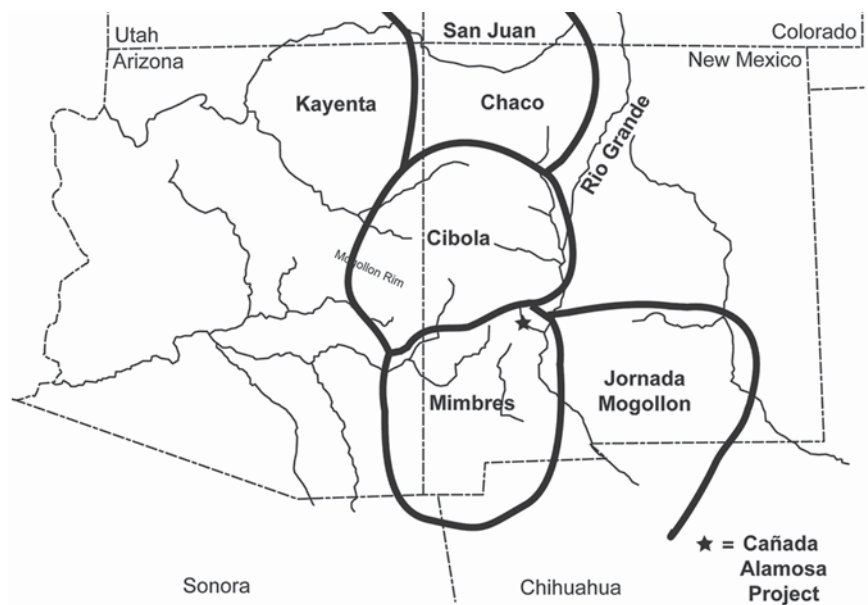
MAP 14.3. Montoya site, LA 88891.



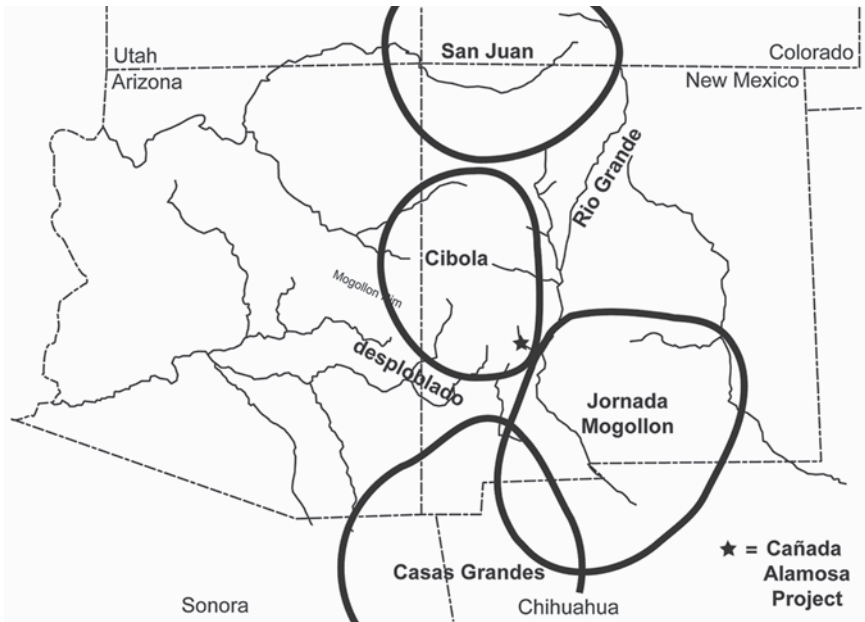
MAP 14.4. Kelly site, LA 1125.



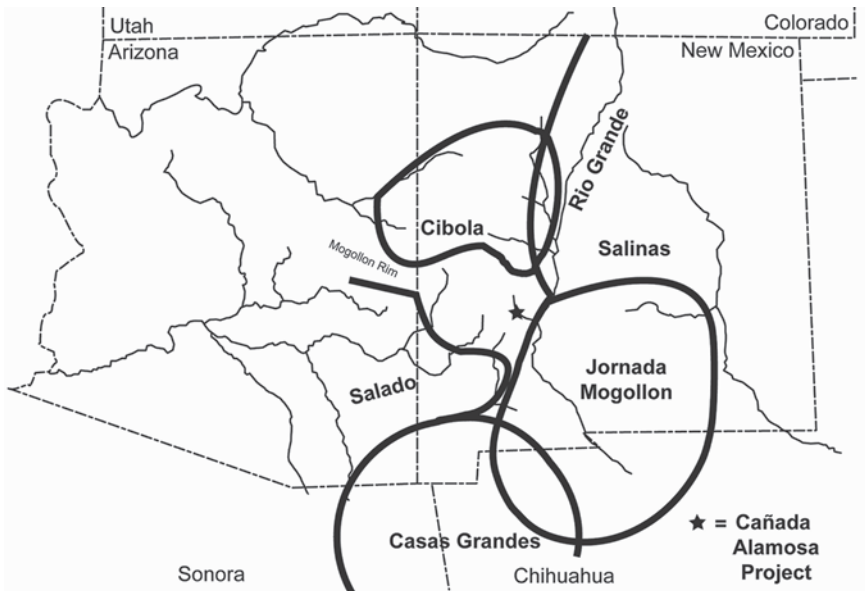
MAP 14.5. Culture areas, AD 700–1000.



MAP 14.6. Culture areas, AD 1000–1150.



MAP 14.7. Culture areas, AD 1150-1300



MAP 14.8. Culture areas, AD 1300-1400.



MAP 14.9. Major drainages and sites.

note that, for the purposes of this discussion, the boundaries of the culture areas depicted reflect the centers of production and the extent of primary distribution for the dominant paint-decorated ceramic types and wares. Map 14.9 provides context for drainages and sites referred to in the discussion.

The archaeological sequence contains a unique, and frequently shifting, blend of southern and northern material culture traits. Similar to the chapter by Deborah L. Huntley et al. (this volume), we use compositional and stylistic analysis of the painted and utility ceramics, obsidian, and architecture (construction techniques and site plans) to examine the evidence of different scales of regional interaction. To date, the project has submitted 600 pottery and raw clay samples to the Archaeometry Laboratory at the University of Missouri Research Reactor for neutron activation analysis (NAA), encompassing eighteen of the nearly forty main ceramic types present, as well as a comparative sample of ceramics from Gallina Springs Pueblo, located sixty miles to the north on the Rio Salado. The entire obsidian assemblage, totaling nearly 800 pieces, has been analyzed by energy-dispersive X-ray fluorescence (XRF); of these, 528 samples can be confidently attributed to one of six temporal contexts found in the four sites. An additional 87 samples from late Pueblo contexts at Gallina Springs Pueblo ($n = 66$) and early Pueblo contexts on the Rio Salado ($n = 21$) have also been analyzed and are included in this discussion. These compositional studies, combined with architectural analysis and stylistic studies of the ceramics, have generated a fascinating and complex data set that shows divergent patterns of interaction, depending on the time period and material type.

METHODS FOR INVESTIGATING INTERACTION AND MOVEMENT IN THE CAÑADA ALAMOSA

The Cañada Alamosa Project is not the study of a single instance or type of movement. Instead, it spans a long period wherein sequential phases or periods reflect different populations and modes of subsistence. As a result, a number of different models are required to explain the varied patterns of artifacts and architecture. Due to the location of CAP near the boundaries of broad archaeologically defined culture areas, most of the suggested movement of people, objects, and ideas either crosses these boundaries (which shift slightly through time) or moves from the center(s) of a particular culture area to its edge. The location on the edges of large-scale patterned differences in material culture (and presumable social groups) allows shifts in regional affiliation and population movements to be more readily inferred from the archaeological record, when compared to sites located within the core culture areas, where population movements leave a less obvious signature.

The suggested movement of people, objects, or ideas is rooted in the materials recovered from CAP and a working knowledge of archaeological investigations in adjacent areas and congruent temporal periods. For the movement of people, we see short- and long-range movements, seasonal rounds, expansion from developed centers, and aggregation. While each of these movements brought objects and people into the Cañada Alamosa, objects also found their way into the canyon via trade. Exactly how that trade manifested itself is difficult to define based on extant data. In some cases (and particularly with ceramics) it seems likely that the Cañada Alamosa residents traveled to the source to obtain materials. In others (e.g., obsidian) it seems more likely that objects were exchanged through a great number of individuals across both long and short distances before finally reaching the Cañada Alamosa. The driving forces behind each of the movements (people, objects, and ideas) vary through time and are a reflection of broader patterns of subsistence and populations across the American Southwest. These patterns include the PII and Mimbres expansions during the eleventh century and the thirteenth-century abandonment of the San Juan culture area.

Our assumptions, inferences, and interpretations are based on three main lines of evidence:

1. Observed and documented patterns of material culture obtained through survey and excavation of four adjacent sites over a thirteen-year period.
2. A robust database developed for ceramics and obsidian. Geological survey and neutron activation analysis employed for ceramics samples and X-ray fluorescence for obsidian samples. Additional data derived comes from NAA of ceramics and XRF analyses of obsidian from multiple sites on the Rio Salado.
3. Comparison to regional data.

MATERIAL CULTURE PATTERNS

As noted by Huntley (this volume), archaeological studies of exchange and movement are inherently based on material culture, but not all evidence is created equal. Individual studies often stress one segment of the material record without adequate consideration of other, potentially divergent, lines of evidence. We avoid this problem by using multiple materials in CAP, but, in so doing, we discover others—namely the difficulties of exactly documenting complex social patterns, such as exchange and population movement, through different lenses. In this section we present specific data relating to regional interaction and exchange for each identified temporal period. Specifically, we address four main types of material evidence for each period: unpainted ceramics, painted ceramics, obsidian, and architecture.

Obsidian, ceramics, and architecture represent three common archaeological features used to assess many forms of interaction. Obsidian and ceramics are particularly useful because they can demonstrate clear links to specific production or procurement locations through the use of compositional studies. It is important to remember that these artifacts represent only end points, and the nature and complexity of the pathway requires further study.

The stylistic ceramic interpretations are derived from established regional typologies. The compositional studies of the ceramics were done by NAA at the University of Missouri Research Reactor, using standard analytical and interpretative procedures outlined elsewhere (Glascok 1992; Neff 2002). The specific nature of the compositional groups defined for this study (Ferguson et al. 2009; Ferguson et al. 2010) is beyond the scope of this chapter, but the results are summarized in table 14.1. NAA studies of the Cañada Alamosa clays and ceramics have been greatly enhanced by the detailed geological survey and mapping of the USGS quadrangle (Montoya Butte), within which the four sites are centrally located (McLemore 2010; McLemore et al. 2012). Virginia T. McLemore's survey has identified the majority of the available clay sources and the geologic context for their varying compositions, providing confidence in assessing which ceramics were locally produced.

The Cañada Alamosa lies in an ideal location for examining long-distance interaction because it is central to large sources of knappable obsidian. Because we are examining large-scale processes with a relatively small assemblage of obsidian from clear cultural contexts, we have combined some specific sources into groups that indicate the direction of the sources from the project area. We do not mean to imply that specific source use is unimportant—only that we are attempting to condense the immense body of available data in order to assess large-scale patterns that reflect changes in resource procurement over time. Figure 14.1 presents the data by context/temporal component and source. Mount Taylor sources (Grants Ridge and Horace Mesa) are combined with the Jemez Mountains sources (mainly Cerro Toledo Rhyolite, Valles Rhyolite, and El Rechuelos) into a northern obsidian group. Small amounts of northern obsidian (Cerro Toledo Rhyolite only) may have been collected from the Rio Grande gravel terraces located just to the east of the project area. The “North (close)” obsidian includes a newly documented source—McDaniel Tank—located approximately 50 kilometers to the north-northwest, across the San Mateo Mountains (LeTourneau et al. 2010). Northwestern sources include Gwynn Canyon and Red Hill. All of the Mule Creek sources (including Antelope Creek, North Sawmill Creek, and Mule Mountains) are combined into the western (“West” in figure 14.1) sources. Interestingly, obsidian sources from farther to the south (e.g., Antelope Wells and Sierra Fresnal) are not represented in the assemblage. All of the above sources are described in detail by M. Steven Shackley (2005).

TABLE 14.1. Ceramic production areas by ceramic type for Cañada Alamosa (CA) and Gallina Springs (GS)

		<i>Assigned Production Area (NAA group numbers)</i>					
Traditional production area	Type	Site	<i>Cañada Alamosa</i>		<i>Gila</i>		<i>Unknown</i>
			(4)	(3, 5, 5a, 5b, 10)	(8)	(14)	
					<i>Rio Grande</i>	<i>Mimbres / Gila</i>	<i>Rio Grande</i>
North Pueblo	Magdalena B/W	GS		24			(1, 6, 9, 11, 12, 13, Unassigned)
	Magdalena B/W	CA	5	19			16
(Rio Salado, Rio Puerco)	Kiatuhlana B/W	CA		12			13
	San Marcial B/W	CA		25			3
	Socorro B/W	CA		20			2
	St Johns Polychrome	CA		29			2
Cibola	Tularosa B/W	CA		27			
(Zuni South, Cebolleta Mesa)	Chupadero B/W	CA		4			5
North Pueblo/East	Mimbres Classic B/W	CA				3	10
Mogollon	Mimbres Boldface B/W	CA					17
(Mimbres, Gila, Rio Grande)	Mogollon R/Br	CA	2		5		19
North Pueblo	Los Lunas Smudged	CA	3	2			14
(Rio Salado)	Pitche Rubbed-Ribbed	CA	1	6			9
Cibola	Magdalena unpainted	GS		17			7
(Cebolleta Mesa, Zuni South)	Reserve Indented Corrugated	CA	13		1		23
	Reserve Plain Corrugated	CA	11				5
Mogollon (Mimbres, Gila, Rio Grande)	Mimbres Corrugated	CA	10				1
Mogollon	Seco Corrugated	CA	29				1
Total			74	185	6	3	17
							137

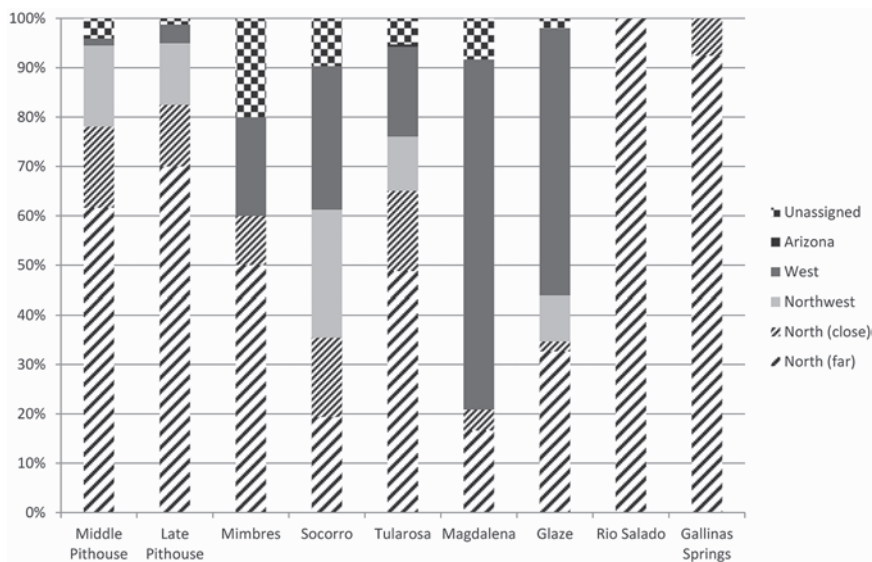


FIGURE 14.1. Obsidian source area proportions by time.

The architectural features of the sites vary considerably through time. The pit-houses are large (8–10 meters in diameter) and exhibit both ramp entrances common to the south and ventilators found in the north. Pueblo architecture styles range from jacal structures during the Mimbres phase to the unshaped stone masonry of the Socorro and Tularosa phases and the shaped masonry walls of carefully selected material of both the Magdalena and Glaze A components on Pinnacle Ruin. Pueblo site plans are equally varied, with scattered small room blocks being the norm during the Mimbres phase and linear or C-shaped room blocks representing the Socorro and Tularosa phases. The Magdalena phase architecture eschewed the broad level terraces for terraced rooms built on a defensible uplift. The Glaze period builders chose the same defensible position but built in linear blocks where possible.

Central-Based Foraging/Seasonal Rounds (Middle and Late Pithouse Periods: AD 700–900)

The earliest period with extensive evidence of occupation is the eighth- to ninth-century pithouse village on the Victorio site (Seamont 2009). The ceramic assemblage is generally Mogollon in character but contains significant quantities of northern white wares, notably San Marcial (aka White Mound) Black-on-white.

Curiously, ceramics representing the tenth century are rare, suggesting abandonment or near abandonment of the Cañada Alamosa during the tenth century. The unpainted ceramics from this context have yet to undergo compositional analysis, but stylistically they are similar to the Mogollon corrugated brown ware types (Alma Neckbanded and Three Circle Neck Corrugated), strongly suggesting a southern link.

The Middle Pithouse period (ca. AD 700–800) has a large assemblage of associated obsidian ($n = 73$), revealing the highest percentage (61.6 percent) from the northern sources of Jemez and Mount Taylor. In contrast, the pithouse architecture looks southern, at least early on—with ramp entrances that were later refashioned into northern-style ventilators. This architectural pattern might indicate a temporal shift from a southern to a northern association.

This well-documented Middle Pithouse period on the Victorio site illustrates the complexity of examining regional influences in multiple material types. The painted ceramics show procurement to the north and south; the obsidian is heavily dominated by the northern sources; and the architecture reflects complex and possibly shifting influences from northern and southern areas.

Less is known about the Late Pithouse period occupation at the Victorio site (ca. AD 800–900) because it is represented only in the upper fill of the earlier pithouses. Thus, the only materials of discernable context are the temporally sensitive painted ceramics. Although the Victoria site likely includes some pithouses from this period, none have been located. Mimbres Boldface Black-on-white dominates the painted wares. Our compositional analysis reveals a very diverse pattern for this type, with connections to the Mimbres Valley. Robert J. Speakman, University of Georgia (pers. comm. 2010) has compared these data to his much finer-scaled ongoing analysis of paint-decorated ceramic production in the Mimbres region. He has matched the Cañada Alamosa samples with production areas all over the Mimbres area, with the notable exception of the eastern portion in the Black Range and Rio Grande areas. Northern white wares (primarily Kiatuthlana Black-on-white) are much less frequent in the Late Pithouse assemblage, suggesting a dwindling contact with the north.

It is our working hypothesis that the Mogollon pithouse village at the Victorio site, located on an ecotone, was the center for systematic exploitation of the surrounding environmental zones. Foraging requires movement, and that movement brought the local group into contact with external groups—some mobile, some less so. Direct contact allowed acquisition of decorated ceramics (San Marcial Black-on-white and Kiatuthlana Black-on-white) from the Cebolleta Mesa and the Rio Salado drainage in the southern Ancestral Pueblo area and would have encouraged intermarriage. The low population apparent in both site size and density during this

period of occupation at the Cañada Alamosa would have encouraged acquisition of exogamous marriage partners. The decorated ceramics may have originated from the external groups or may have been acquired by Cañada Alamosa populations from available production areas during their foraging cycle.

Movement of obsidian most likely involved a number of down-the-line trades until only a few cores or flakes reached the Cañada Alamosa populations through contact with the external groups with greater access to obsidian (primarily Mount Taylor and Jemez). As northern obsidian dominates the CAP pithouse assemblage, it is assumed that contacts to the western sources were limited. This pattern contrasts with the Pithouse period in the Mimbres Valley, which is dominated by obsidian from sources to the west, predominantly Mule Creek.

Intermarriage would have resulted in the movement of individuals from one group to another and, perhaps more importantly, would have been the primary mechanism for the movement of ideas. Equal numbers of northern and southern painted ceramics on pithouse floors suggest intermarriage, rather than just trade, but it is in the alterations of pithouse architecture where the movement of external concepts into the Cañada Alamosa is most visible. In one instance, a ramp entrance (southern trait) was remodeled into a ventilator (northern trait).

Although clearly a part of the Mogollon pithouse tradition, the Cañada Alamosa pithouse occupation is on the very edge of the Mogollon culture area and has little evidence of producing its own painted ceramics. NAA data indicates the Mogollon Red-on-black and Mimbres Boldface Black-on-white found in the project area were produced at a number of locations on the Gila and Mimbres drainages. Presumably, the common cultural connection inferred from the dominant architectural and ceramic data reflects trade and, perhaps, long-term familial ties with populations on those drainages. This suggestion explains the acquisition of Mogollon painted ceramics and very limited amounts of western obsidian (Mule Creek, etc.) by the Cañada Alamosa population.

Expansion from the Centers (Mimbres Classic and Their Socorro Neighbors: AD 1000–1100)

With the exception of a single room block, the painted ceramics and architectural features of the Montoya site strongly suggest an affiliation with the Mimbres region to the south (Laumbach and Laumbach 2006). Some of the Mimbres painted ceramics compositionally match production in the Mimbres Valley, as is seen in the Late Pithouse period, but the NAA data of Mimbres white wares from the Cañada Alamosa points to a decisive shift from the western production areas in the Late Pithouse period to pottery produced in the eastern Mimbres region. The unpainted ceramics appear to be largely, if not entirely, locally made.

There are only eight obsidian samples in clear association with the Mimbres ceramics. Five of the samples are from northern sources, one is from the local McDaniel Tank source, and two are from the west. The northern obsidian is much more prominent at Cañada Alamosa than at contemporary sites in the Mimbres Valley (Taliaferro et al. 2010 and ongoing unpublished work in the Mimbres Valley by Jeffrey R. Ferguson), suggesting, perhaps, a different procurement mechanism for obsidian versus painted ceramics.

The general site layout is similar to sites in the Mimbres region in that the site is composed of multiple small room blocks loosely organized around a central area. Upright stones (*cimientos*) mark the foundations of shallow jacal structures that include both small rectangular rooms and larger ramadas, or sheltered work areas. Only a few masonry rooms found on survey seem to be associated with the Mimbres period occupation. The dominance of jacal architecture supported by foundations of upright stones may reflect multiple short-term occupations during this period.

At the beginning of the eleventh century, both the Mimbres and Chaco areas were experiencing a florescence accompanied by an increase in population. The resulting movement of people from the core into more marginal areas (such as Cañada Alamosa) has been called the Pueblo II (PII) expansion (Clark and Laumbach 2011:297–320; Sebastian 1992:28–29; Shafer 1999:95–106). This expansion is supported by greater precipitation in the ensuing century that increased the success of dryland farming. This outward movement of people also brought objects and ideas to the hinterlands (including Cañada Alamosa), eventually resulting in the establishment of Mimbres ceramic production areas in the Black Range and Rio Grande areas. Once the new production areas were established, NAA data suggest that most of the painted ceramics from CAP were acquired through trade, travel, or both from these eastern Mimbres sources. This pattern contrasts to the Late Pithouse period at CAP, when the Mimbres white wares in CAP were primarily produced in the Mimbres and Gila drainages to the southwest.

Simultaneously, populations on the southern edge of the Chaco sphere of influence were spreading south into the marginal farming environment of the Rio Salado. Evidence of contact with Cañada Alamosa consists primarily of sherds of Socorro Black-on-white in association with Mimbres Classic assemblages. Here there are two reasonable explanations: (1) relationships between Cañada Alamosa and Rio Salado populations continued unabated from the previous Pithouse period, or (2) new relationships were developed via co-use of the Plains of San Agustin as a resource area.

Obsidian procurement during this period seems to have been at an all-time low and was more or less equally divided between northern and western sources. As before, the mode of movement from the sources was likely in small amounts

exchanged through numerous middlemen. We should also consider the possibility of reuse of obsidian brought to the canyon during earlier periods. Given the limited quantities and small size of individual artifacts, the impact of obsidian from earlier components is difficult to evaluate.

Pueblo Period Convergence: A Short-Range Movement (Socorro Phase: AD 1130–1200)

The occupation of the Kelly Canyon site overlaps the terminal Mimbres occupation at Montoya and exhibits architectural patterns very much like sites to the north and west (Laumbach and Laumbach 2006). The painted ceramic assemblage shifts from the Mimbres-dominated assemblage found on the Montoya site to an assemblage dominated by Socorro Black-on-white at the Kelly Canyon site. As is typical, there is no indication of local painted pottery production. The unpainted ceramic production is not entirely clear, but there is evidence for movement of corrugated ceramics from northern production areas on the Rio Salado as well as ceramic production in the Cañada Alamosa.

The early years of the twelfth century saw less and less rainfall, and a sustained drought began circa AD 1130 (Grissino-Mayer et al. 2002:24). The spring-fed waters of the Rio Alamosa, however, continued to flow, and we hypothesize that the combination of water and existing relationships between the Cañada Alamosa and Rio Salado populations contributed a pull factor to the push factor of drought, making the quickly drained Rio Salado unable to support agriculture. The result was a short-range movement of one or more Socorro phase communities to the Cañada Alamosa (Laumbach and Laumbach 2006). This Socorro phase movement is inferred from the northern site plan (linear room blocks of unshaped masonry associated with kivas) and the ceramics (copious quantities of Socorro Black-on-white and its accompanying distinctive corrugated types). NAA data shows that all of the Socorro Black-on-white, as well as some of their distinctive corrugated wares (Pitoche Rubbed-Ribbed and Los Lunas Smudged), was imported from a northern source. Thus, it was a movement of people, objects, and ideas. Whether or not the migrant communities maintained ties with villages on the Rio Salado is unknown.

The obsidian from Socorro phase components at Cañada Alamosa ($n = 31$) suggests that perhaps they did not maintain ties to the north. Obsidian remains an enigma, as a very limited number of samples were recovered from the discrete Socorro component on the Kelly Canyon site (three from the north, two from the west, one local, and one unassigned; figure 14.1). The twenty-four samples from Socorro phase components on the Montoya and Kelly Canyon sites are slightly weighted toward western sources. These data indicate that roughly equal amounts of obsidian were acquired from both the north and the west, an interpretation that

stands in stark contrast to the obsidian sample from Socorro sites on the Rio Salado ($n = 21$), where the assemblage is dominated by northern obsidian (90 percent Mount Taylor and 10 percent Jemez). This pattern suggests that Socorro phase sites on the Rio Salado had ready access to the northern obsidian sources, and the movement to the Cañada Alamosa appears to have limited access to either the actual source or trading networks with access.

In addition to the lack of obsidian, the Socorro occupations at Kelly Canyon and Victorio have a notable absence of shell artifacts compared to sites to the north and south. This may relate to the breakdown of regional exchange as a result of the post-Mimbres and post-Chaco reorganization.

Pueblo Period Assimilation (Tularosa Phase: AD 1200–1290)

In the latter twelfth century, Mimbres and Socorro descendents in the Cañada Alamosa abandoned the small sites and the extensive settlement pattern for aggregation at the 450-room Victorio site (Laumbach and Wakeman 1999). By the early AD 1200s, production areas for both Socorro Black-on-white and Mimbres Black-on-white had collapsed, and those types were no longer available for import. Based on both the site plan and the ceramics of the Victorio site, the local population then aligned themselves with the Cibola culture area, importing Tularosa Black-on-white and St. Johns Polychrome to fill their need for paint-decorated pottery, a need for which feasting, display, and ideology may have played a major role (Spielmann 2004:210–32). Salt from the Zuni Salt Lake must have always been a significant connecting factor, but it may have taken on an added, perhaps ritual, importance during this period. Unlike the preceding Socorro phase, the unpainted ceramics appear to have been largely locally produced.

While the architectural methods appear to be a mixture of the Mimbres tradition (cimientos and jacal) and the Socorro tradition (unshaped stone masonry), the site plan is more reminiscent of the large sites in the Zuni area characterized by extensive communities of small room blocks built around a larger and perhaps communal room block (Reed et al. 1992). Given the similar site plans, it is easy to speculate that social organization in the Cañada Alamosa also mimicked that of the Cibola area and that the acquisition of painted ceramics supported feasting ceremonies derived from the Cibola area (Spielmann 2004).

The catalyst for this increased interaction with the Cibola area during the thirteenth century may well have been access to salt from the Zuni Salt Lake, although it must have been an attraction during earlier periods as well. Perhaps access to the salt had become more controlled or access to other sources of salt had been cut off. Movement of ceramics and other goods from the Cibola culture area would have featured long walks across the Plains of San Agustin.

The obsidian recovered from Tularosa phase contexts ($n = 209$) greatly increases from the Socorro phase, and the amount of obsidian from western sources (29.2 percent) also increases dramatically, although significant amounts of Mount Taylor and Jemez obsidian (48.8 percent) are also present. Although obsidian from the northern and western sources might well have arrived in the Cañada Alamosa via direct routes, it is also possible that obsidian from both sources could have been acquired via secondary sources (people) in the Cibola culture area. Again, it should be stressed that many of the Tularosa room blocks were built on top of earlier components, and mixing and/or scavenging of early obsidian is possible.

There is also NAA and ceramic evidence that the Cañada Alamosa population was in direct contact with Techado Spring Pueblo, an 800-room site north of Quemado, whose history ends in a bloody massacre (Smith et al. 2009). Sherds of Techado Polychrome, a distinctive late variant of St. Johns Polychrome, have been found in numerous contexts across the Victorio site. NAA data indicates that the St. Johns Polychrome from CAP is from the same clay group as that from Techado Pueblo (Peeples 2011:463). Techado Pueblo appears to have been hurriedly built, with a wide variety of building techniques, suggesting disparate groups coming together for mutual support and defense. It is quite possible that the late room blocks on the eastern edge of the Victorio site (referred to as “the suburbs”) are the result of a similar aggregation of family groups from surrounding areas adding to the population during the Tularosa phase. Each of these new groups may have added to the inventory of ceramics, obsidian, and other goods.

The Migrants: A Long-Range Movement (Magdalena Phase: AD 1240–1290)

During the mid-thirteenth century, the population of the San Juan culture area in northwestern New Mexico was moving out of its ancestral homeland and creating a migration stream that can be traced to the Rio Puerco (Baker and Durand 2003; Bice and Sundt 1972; Eckert 2008; Roney 1996), then to Gallina Springs, northwest of Magdalena (Davis 1964; Ellis 1959), and finally to Pinnacle Ruin at the Cañada Alamosa (Clark and Laumbach 2011; Lekson et al. 2002). The reasons advanced for this migration from the homeland include overpopulation, growing seasons shortened by long winters, and a great drought (Jones et al. 1999; Peterson 1988; Salzer 2000). The reasons for the successive movements are less clear (dissatisfaction, bad neighbors, overpopulation, etc.). Radiocarbon dates from both the Victorio and Pinnacle sites strongly support a migrant arrival while the Tularosa phase population was in place at the Victorio site.

What is clear is that, to each location along the path of the migration stream, these groups brought their distinctive carbon-painted pottery (including ceramic production methods) and their notion of architectural style and site placement

(people, objects, ideas) (Lipe 2010); however, the sites are lacking other characteristic elements of Mesa Verde culture, such as mugs and keyhole kivas. NAA data has clearly linked carbon-painted ceramics at the Pinnacle Ruin with ceramic production at both Gallina Springs and the Cañada Alamosa—representing the only clear painted ceramic production in the canyon. Furthermore, two additional clay sources represented by Gallina Springs ceramics may eventually be linked to carbon-painted ceramics on the Rio Puerco, thereby connecting the migration chain ever closer to its origin. The NAA data also indicate that relationships were maintained between the various links in the migration chain, while the obsidian data suggests otherwise.

As with the Socorro phase movement a century earlier, the obsidian is an enigma. It was expected that the Mount Taylor obsidian that dominates the Gallina Springs assemblage would be part of the package brought by the migrants to the Cañada Alamosa. Instead, only a very small percentage of obsidian in Magdalena phase contexts ($n = 24$) derives from northern sources (16.6 percent); the majority of the obsidian is from the west (70.8 percent).

Architecturally, the Magdalena phase pueblos at Gallina Springs and Pinnacle Ruin are built of compound walls made of local, shaped latite slabs, a building style and material not used by earlier groups in the canyon. Pinnacle Ruin was constructed as a compound on a rocky uplift with restricted access, unlike all the preceding sites at the Cañada Alamosa, which are on flat, open terraces. This type of fortified construction and site plan resembles sites in the Mesa Verde/San Juan culture area for the same period (Stein and Fowler 1996:117–24).

What is most intriguing about Pinnacle Ruin and the other sites associated with the migration stream is that they appear to have remained aloof from their Tularosa phase neighbors—at least in terms of exchange of their painted ceramics. On the other hand, both groups used the same corrugated utility ware, with Cibola Gray Ware being the ware of choice on the Rio Puerco/Cebolleta Mesa interface and its brown ware equivalent, Reserve Indented Corrugated, being popular with both groups on the Rio Salado and the Cañada Alamosa. This pattern suggests that while the more generic utility ware might have been accessible to and/or desired by both the local population and the migrants, the painted ware was more symbolic of social affiliation. John Roney (1996:163) suggests that the two groups were separated by both language and social organization. Ongoing work with additional ceramic compositional studies will hopefully help to resolve some of this complexity.

Radiocarbon dates and stratigraphy indicate that both residents and immigrants at Victorio and Pinnacle Ruin had largely abandoned the Cañada Alamosa by AD 1300, with the Victorio site occupation probably ending first. With the exception of an isolated small room block on the Victorio site, radiocarbon dates clearly point to

an abandonment of the site by AD 1290, if not before. Likewise, radiocarbon dates associated with Magdalena phase contexts at the Pinnacle Ruin are all earlier than 1290–1300 at two sigmas.

REOCCUPATION (EARLY CLASSIC PERIOD GLAZE A: AD 1300–1400?)

The stratigraphic record of three separate features at the Pinnacle Ruin suggests reoccupation after AD 1300 and more likely after 1320. The ceramics of the new immigrants are associated with the Zuni Glaze Wares and limited contacts to the Salado sites to the southwest and the El Paso phase sites to the south and southeast. The painted ceramics from the Glaze Ware occupation are strongly linked with a number of production centers, mostly to the northwest; but these assessments are based entirely on attributes of temper and style. The glaze wares are sherd tempered, which links them to either Zuni or Acoma areas and separates them from the Rio Grande Glaze production areas.

The reoccupation of Pinnacle is marked by the razing and filling of earlier structures, the construction of new room blocks, and, most visibly, the arrival of a variety of early glaze wares, primarily from the Cibola area. It is important to note that this later connection with the greater Zuni area differs from that experienced at the Victorio site during the Tularosa phase in that the earlier connection was made by a population already ensconced in the Cañada Alamosa, while the Glaze period occupation at Pinnacle Ruin was established in what appears to have been an abandoned canyon. Another indication of the reoccupation is that while Heshotauthla Glaze Polychrome and Kwakina Glaze Polychrome were produced in the Zuni area in the late 1200s, they do not appear in the Magdalena phase contexts. Instead, they are limited to contexts where radiocarbon dates are later than AD 1300 at two sigmas. The interpretation is that the glaze wares and the population who brought them arrived from the Cibola culture area sometime after 1300 and settled at Pinnacle Ruin. The limited number of glaze sherds at Pinnacle leaves open the possibility that the entire assemblage could have arrived with the population. Both the painted and unpainted ceramics from this context have yet to undergo compositional analysis.

The obsidian data from this period ($n = 98$) is problematic, as it is undoubtedly mixed with that of the underlying Magdalena phase materials. More than 50 percent is from the west, with about 30 percent from the north. Again, the mechanism of that movement is difficult to determine. It is likely that much of the assemblage had already been imported into the canyon and was reused. The remainder likely came through contacts in the Zuni area, as much of the region to the southwest was abandoned during the 1300s.

Architecturally, the walls associated with the glaze component at Pinnacle Ruin are reminiscent of the shaped stone walls found in the Cibola culture area and stand in sharp contrast to the pre-Magdalenan phase construction in the Cañada Alamosa.

MATERIAL-SPECIFIC TRENDS

As the Cañada Alamosa population ebbed and flowed and was augmented by outside groups, connections to specific sources of painted ceramics, obsidian, and architectural influence were enhanced, altered, or abandoned by changes in distance, social structure, settlement patterns, and regional demographics. Consequently, the material culture of the Cañada Alamosa sequence is a reflection of a broader pattern of interaction and movement in the prehistoric Southwest. Having summarized the trends by temporal period, it is important to step back and examine the differences in the material types discussed in the above cultural sequence, both in terms of the nature of the possible source areas and the role of the material among the local consumers.

Obsidian sources are not evenly distributed on the landscape, at least not in New Mexico. End points in the movement of obsidian can often raise more questions than answers. For example, during the Magdalenan occupation at Pinnacle, did the occupants obtain their western New Mexico obsidian through direct procurement trips, exchange with groups to the south and west with specific connections to source material, occasional and unpatterned exchange with neighbors, or perhaps by scavenging discarded pieces from other sites in the canyon? It is possible to venture an informed guess, but more detailed study is required.

Obsidian also presents another interesting contrast to ceramics, especially painted ceramics. It is not clear that obsidian procurement and use, particularly from specific sources, held substantial social significance. Most southwestern obsidians are fairly consistent in color and quality (although there are differences in cobble size). Did the source of the material matter, and would someone at the end of an exchange have known or cared? There are places and times in other parts of the world where obsidian held social significance, and the source (or at least the physical appearance) of the material seems to have mattered (Dillain 2002; Kroeber 1971); but this is not apparent in the Cañada Alamosa assemblage.

In contrast to obsidian, painted ceramics are assumed to carry more individual social value. But, like obsidian, the specific role is unclear. The inhabitants of the four sites in the Cañada Alamosa study made efforts to obtain paint-decorated ceramics from outlying areas. Their procurement patterns seem to match large-scale social and political changes in the surrounding regions and likely reflect direct social

connections. But were the ceramics intended to convey specific social connections, or were they simply reflecting procurement established through existing channels? It is interesting to note that the only period with evidence of local painted-ceramic production is the Magdalena phase migrant community, which had the least evidence of regional interaction.

In all cases in which we have ceramic compositional data, there is evidence of predominantly local production of unpainted ceramics, a common pattern in many regions of the American Southwest. Were these simply in such high usage that import was not economically viable? Did local groups lack the skills, knowledge, and/or raw material to produce painted wares but unpainted ceramic production was possible? Is it simply a matter of not needing to convey the same social information in unpainted compared to painted ceramics? The one exception to this pattern in CAP is that NAA data indicate that the Socorro population was using corrugated wares produced in the Rio Salado drainage.

While ceramics and obsidian have the potential to link locations of production or procurement directly to the Cañada Alamosa, the architectural building techniques and site plans present a different challenge. When a painted vessel was obtained from a surrounding region, it was largely unmodified until discarded. Architecture presents a more complicated picture. The construction of a single room or pithouse can include a mixture of architectural elements characteristic of both extralocal and local traditions. Furthermore, architecture can provide insight into culturally linked changes incorporated over the use-life of the feature. The local environment and the resources available also heavily influence architecture. One cannot make cut sandstone masonry when there is no sandstone; thus, architecture presents severe limitations to raw material transport.

SCALE, LOGISTICS, CONTEXT, AND EXPLANATION

It is clear from the preceding discussion that long-distance movement of people, objects, and ideas into the Cañada Alamosa varied considerably in terms of scale, logistics, and context, depending on the time period discussed. Pithouse populations at the Cañada Alamosa are interpreted as small and mobile. The larger and growing pithouse populations are situated on the major drainages (Rio Grande, Mimbres, Gila) (Diehl and LeBlanc 2001:119; Lekson 2006a:39–41; Phillips and Greenwald 1998). The comparatively limited arable land and its position on an ecotone made central-based hunting and gathering a major part of pithouse period subsistence. Seasonal movement fulfilled both the needs of subsistence and the requirements of exogamy. The resulting movement of small groups created trade connections that ultimately brought people, objects, and ideas to the Cañada Alamosa.

This early system of movement and exchange was truncated during the tenth century, when the canyon was largely abandoned. One suggested interpretation is that the Cañada Alamosa pithouse period was attracted to the growing centers of the Mimbres sphere.

The early Pueblo (Mimbres) population in the Cañada Alamosa was small but with an extensive settlement pattern that perhaps represents only an intermittent occupation of any particular site. As part of the Mimbres version of the Pueblo II expansion, they were likely composed of multiple extended families reaching out to find arable land along the unoccupied boundaries. Once there, they made contact with other expansionists linked with different ceramic and architectural traditions. This association led to exchange and long-term relationships. Thus, the Mimbres expansion into the Cañada Alamosa was driven by a favorable climate and the need to support a growing population that had been nurtured in the more productive centers.

That long-term relationship played a major role in attracting population into the Cañada Alamosa during the droughts of the early 1100s. Termed the “terminal PII expansion” (Clark and Laumbach 2011:307), at least a part of the Rio Salado population (one site excavated, two more documented on survey) moved an additional sixty miles farther south to join their Mimbres kindred. The combined population might have doubled the population size of Cañada Alamosa. In this case movement was fueled by the reversal of climatic good fortune and encouraged by already developed social ties with the local Mimbres population.

After a period of adjustment, the entire population of the Rio Alamosa aggregated on or near the Victorio site. Exactly why, we do not know, but the result was a regional center that ultimately boasted more than 450 rooms. Arguments can be made that perhaps fewer than 200 rooms (150–200 people) were simultaneously occupied, but that estimate still leaves the Victorio site as the largest pueblo for many miles in all directions. And, as a center, it attracted others from the region. Each such arrival, probably in small family groups, brought people, objects, and ideas. The timing of this aggregation coincided with episodes of abandonment and reorganization in both the Mimbres area to the south and the Rio Salado to the north, effectively eliminating the production areas for Mimbres and Socorro Black-on-white. Thus, it was the regional dissolution of previously viable ceramic production areas that encouraged the Cañada Alamosa populations to increase connectivity to the west, a connection enhanced by the availability of salt. The result was a flow of ceramics, obsidian, and, likely, people and ideas from the west.

The Magdalena occupation of Pinnacle was clearly a part of a much longer migration stream from the San Juan culture area. By the time they arrived at the Cañada Alamosa, they were practiced at movement and clingly brought with them their

objects (carbon paint ware) and their ideas/methods (architecture and ceramics). The number of Magdalena phase rooms on Pinnacle is extremely difficult to determine, but a population of 100 to 150 people is possible. The arrival of this population was due to a number of stressors, including the long, cold winters of the early thirteenth century that forced the eventual abandonment of the San Juan culture area. This migrant group, searching for a new home, found at least temporary quarters on the Cañada Alamosa. They brought with them carbon-painted ceramics, architectural innovations, and their own social order and organization. Unlike the earlier Socorro phase movement into the canyon, there is no evidence of assimilation with the local group.

Abandonment of the canyon by residents of the both the Victorio and Pinnacle sites appears to have coincided with the great drought in the late thirteenth century. The increased precipitation in the fourteenth century would have revitalized the uplands and created a pull factor that likely inspired recolonization of the canyon. The new residents of the Pinnacle Ruin were connected to the Zuni/Cibola culture area (the glaze wares) and may have been descendants of the Victorio population. They razed and rebuilt over the old Magdalena walls, creating a fortified outpost of the greater Cibola world.

ASSIMILATION AND HYBRIDIZATION AT THE CAÑADA ALAMOSA

When considering the populations that met and mingled in the Cañada Alamosa, it seems that most such episodes resulted in assimilation and hybridization. *Assimilation*, as used here, is the process wherein an individual or small group joins and assumes the characteristics of a larger group, while *hybridization* occurs when two groups merge to form a single group with characteristics of both ancestral groups. The archaeological data suggest that assimilation and hybridization took four different forms:

1. The first and earliest occurred during both the Middle and Late Pitohouse periods as well as during the early Pueblo (Mimbres) phase, when specific individuals from neighboring groups (brides/grooms) assimilated into the local social matrix, bringing external forms of paint-decorated ceramic styles and architecture but not the entire corpus of material culture.
2. The second variation involves the merging of two distinct and complete social units, each represented by a full suite of representative material culture. The twelfth-century movement of Socorro phase pueblos to join an extant Mimbres population in the canyon exemplifies this pattern. In this case, the assimilation took time. Perhaps the process required decades before the two groups felt

comfortable enough to live in the same sites and function as the same people. The result was an aggregated, hybrid population whose varied architecture continued to reflect different origins but whose ceramics reflected common connections and perhaps common values.

3. The third variation is the individual and/or individual family group that joined the already aggregated and growing population. This is most visible archaeologically in the suburbs of the Victorio site, where, during the Tularosa phase, small room blocks were hastily built without much surface preparation and ceramic assemblages are low density and a bit more varied, suggesting nonlocal origins for the builders. The low artifact density around these room blocks also indicates that the newcomers either arrived very late in the occupation of the site or left very soon after arrival. In either case the process of assimilation would have been truncated, and merging or hybridization may not have taken place, at least in that location.
4. The fourth variation is the arrival of a completely distinct social unit that does not merge with the local group. The Magdalena phase occupation at Pinnacle best characterizes this scenario. Radiocarbon dates, associations of temporally diagnostic ceramic types, and stratigraphy leave little doubt that the Tularosa phase and Magdalena phase populations were contemporary, at least for a short time. But, like their counterparts on the Cebolleta Mesa and the Rio Puerco (Roney 1996), the only visible commonality is the use of the local indented corrugated ware. Otherwise, the two populations seem to have maintained their separate social order. In this case, there is no evidence to support either assimilation or hybridization.

CONCLUSION

It would appear that the centers of production and areas of primary distribution for specific ceramic types that largely define the archaeological constructs that we refer to as culture areas waxed and waned and were recreated to meet the needs of populations affected by stability, change, and turmoil. The Cañada Alamosa populations are first linked strongly to the Mimbres/Mogollon culture area but with strong ties to the Cibola culture area. This northern connection was maintained, however intermittently, from the AD 700s until 1100, when adverse climatic conditions led to movement, assimilation, and, finally, aggregation of populations from the two culture areas. The resulting hybrid population found itself isolated from the ceramic production areas that contributed to their diversity and allied themselves to a production area that, to archaeologists at least, made them part of the emerging Zuni world. Their place on the edge of that world was shaken by the arrival of a coordinated migrant group from the San Juan culture area. Both groups coexisted,

apparently uneasily, for a time, and then both were gone. The canyon saw one more pueblo occupation, this time from the Cibola culture area.

Thus, we have a 700-year sequence of interaction that ultimately involved populations from at least three culture areas. The accompanying sequence of ceramic types is the primary evidence aligning a particular group or time period with one or more culture areas. Did ceramics reflect relationships, or were they involved in creating relationships? For the most part they reflected relationships, but in certain situations acquisition of nonlocal ceramics must have stimulated the desire to acquire knowledge of customs and ideas that transformed the recipients. This is perhaps most possible during the Tularosa phase, when the acquisition of Tularosa Black-on-white and St. Johns Polychrome may have also introduced feasting and other customs that drew the hybrid Cañada Alamosa population into the custom and culture of the incipient Zuni world.

Finally, the various movements of people, objects, and ideas interpreted from the Cañada Alamosa Project data provide a microcosm of the range of movements that affected the Pueblo Southwest. Each movement had its own need, born in the conditions of the time that it was implemented. Some affected significant areas of the Southwest, while others were of only local impact.

ACKNOWLEDGMENTS

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Modeling Post-AD 700 Population Movements and Culture in the Upper San Juan Region

ERIK SIMPSON

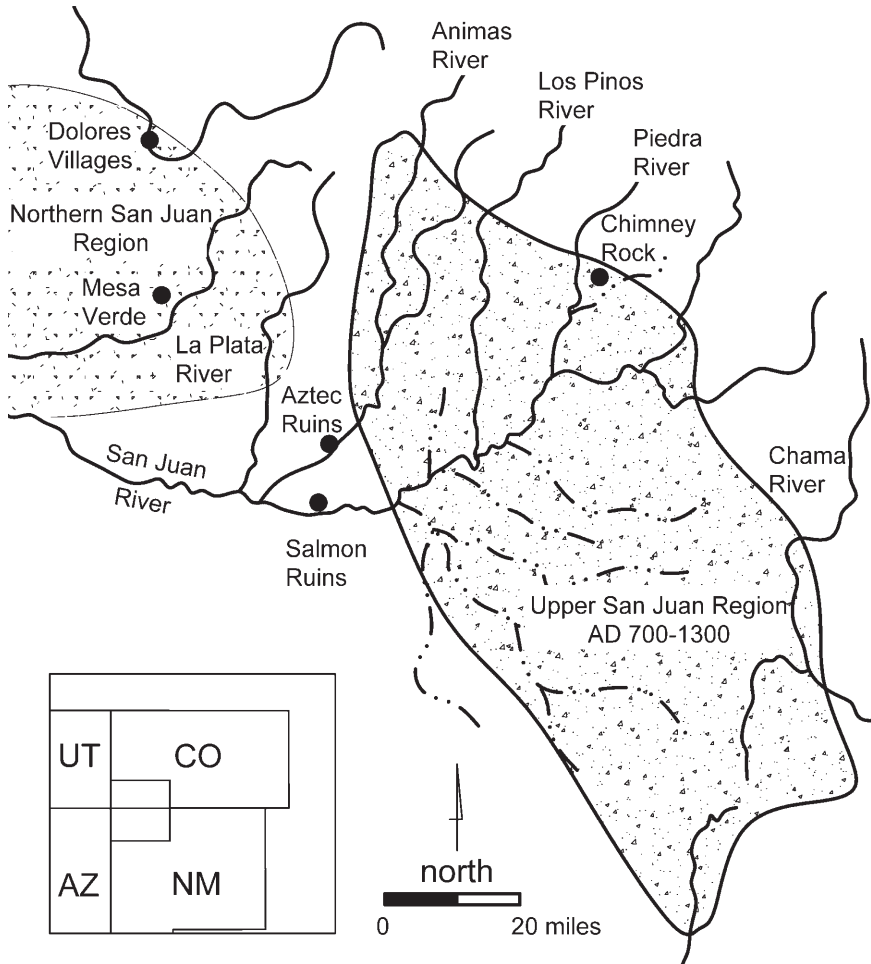
This chapter explores nearly six centuries of population movement across a large portion of the northern Southwest and related fluctuations of group identity. The goal of this chapter is to document Upper San Juan movements and swings in identity between the AD 700s and AD 1200s and to explore the social and historical contexts that prompted them (MacSweeney 2009; Ortman and Cameron 2011). Understanding the relevant contexts associated with the observable patterns of movement and identity provides an opportunity to go beyond their documentation and offer explanations as to the causes of their occurrence (Huntley, this volume).

The movement of people and their identity are often entangled topics in archaeological research (Kulisheck, this volume; Ortman and Cameron 2011). Archaeological discussions of movement tend to focus on the movement of people out of one area and into another where their particular cultural attributes are unique enough in the new cultural environment to be recognizably distinct (Huntley, this volume; Huntley et al., this volume). This form of movement into an area already inhabited by people who are somewhat culturally different can occur when physical conflict, environmental stresses, or a combination of factors that make emigration from an area desirable or when the potential to remain in one's homeland still exists, but people seek new opportunities elsewhere. While this form of movement occurs in the Upper San Juan region as migrants from adjacent areas move there in the mid-AD 700s, another form of movement is more common: movement into uninhabited areas.

The archaeological identification of both sorts of population movement can be accomplished by a variety of methods, but those of interest here include changes in material culture and patterns of regional chronometric data. Aspects of material culture inform on both movement and identity. Archaeologists have long relied on stylistic attributes of material culture, such as painted designs on ceramics or architectural technology and style, to recognize cultural affiliations (e.g., Ferguson et al., this volume). While such highly visible attributes are often used to mark an individual or group's identity, the downside is that they can be manipulated easily and crosscut different levels of identity in complex ways not easily sorted out (Curta 2011). Instead, to understand the cultural origins of a particular group, more robust methods that examine low-visibility aspects of the group are employed (Stark 2006; Stark et al. 2008b). An example is to compare technological characteristics that are inherent in a manufacturing tradition, such as the selection of particular tempers in the production of ceramics. The notion of what an appropriate type of temper should be (e.g., crushed rock versus uncrushed sand) is typically introduced to the potter during the process of learning the craft from older potters who, in turn, learned it from an earlier generation. This process of imparting knowledge through successive generations creates learning networks that have the potential to persist, despite changes in other areas of material culture and identity.

As Jeremy Kulisheck discusses in chapter 6, population estimates are important to understanding the cultural dynamics of a region. Minimum population numbers are provided for the Upper San Juan in an effort to demonstrate the size and stability of Upper San Juan populations. This is prudent for making the events of the Upper San Juan more easily comparable to other areas and because previous models have tended to underestimate the size of the population and suggest Upper San Juan peoples moved in and out of the region relatively frequently (Potter et al. 2012; Wilshusen and Van Dyke 2006).

In addition to providing a study of movement and identity, this chapter also presents Upper San Juan residents in light of the dramatic social and cultural changes of the early Pueblo period that were occurring to the west (Allison et al. 2012; Wilshusen et al. 2012). This position contrasts with the popular narrative that they were directly participating in these changes. Certainly, the transformations of the early Pueblo period played a role in the social and cultural evolution of the Upper San Juan region, but more as a stimulus to which populations responded and reacted. In this chapter I argue that Upper San Juan inhabitants were actually actively resisting events occurring to the west and that this active resistance forged an enduring part of their overall identity.



MAP 15.1. The Upper San Juan region in the northern Southwest.

UPPER SAN JUAN MOVEMENT AND IDENTITY

Numerous references are made to adjacent regions of the northern Southwest, the Upper San Juan, and the Northern San Juan (map 15.1). These areas become increasingly dissimilar through time and have a long history of distinct occupational patterns and populations. The Upper San Juan region is here defined as the watershed upstream of Bloomfield, New Mexico, on the San Juan River and upstream of Aztec, New Mexico, on the Animas River. This area was continuously occupied by people with cultural patterns that were distinct from neighboring regions by at least the

early AD 700s and who maintained a distinct and evolving identity until the late AD 1200s. This unique identity likely has roots in the Upper San Juan region since at least the Basketmaker II period and is part of a probable continuous occupation (Charles et al. 2006). The Northern San Juan region here refers to the geographical area generally associated with Mesa Verde in southwestern Colorado and southeastern Utah.

These two regions can be distinguished archaeologically by ceramic and architectural characteristics. The ceramic traditions of the two regions differed in temper and paint types. The Upper San Juan tradition is typified by the use of sand tempers and organic paint, whereas in the Northern San Juan, populations made use of crushed rock and iron- or manganese-based matte mineral paints (Breternitz et al. 1974; Eddy 1966; Reed and Goff 2007; Wilson and Blinman 1993). Crushed rock and both glaze and matte mineral paints occur in the Upper San Juan and become part of the local tradition, but as will be discussed, these traits appear to reflect the presence of Northern San Juan migrants in the Upper San Juan region.

During the early- to mid-AD 700s, the two areas differed architecturally only in the shape of residential pit structures and the complexity of their internal features (Eddy 1966; Kane 1986). By the mid- to late AD 700s, architectural changes associated with the social and cultural transformations occurring in the Northern San Juan were sufficient to make a clear contrast to Upper San Juan styles. The latter maintained the earlier style of residential pit structures with ephemeral storage surface structures, while Northern San Juan residents were living in multi-household surface room blocks and sharing pit structures that served limited residential functions along with increased nonutilitarian functions (Wilshusen et al. 2012).

AD 700S TO EARLY AD 800S: IDENTITY OF RESISTANCE

Minimal population numbers in the Upper San Juan region during the AD 700s and AD 800s are estimated from residential structure counts obtained from New Mexico (New Mexico Cultural Resources Information System, or NMCRIS) and Colorado (Compass) state archaeological site databases (Simpson 2010). These are summarized in table 15.1. Previous estimates of Upper San Juan household size have been based on ethnographic analogies and residential structure sizes (Adams 1975; Bellowado 2007; Eddy 1977; Potter et al. 2012). Following the range provided by these earlier estimates, an Upper San Juan residential unit might have contained four to six individuals. It should also be noted that the population numbers provided in table 15.1 are minimum estimates, as they are based on known residential structures, with no effort here to extrapolate the number of structures yet to be identified in unsurveyed areas.

TABLE 15.1. Upper San Juan minimum population estimates

<i>Dates</i>	<i>Number of residential structures</i>	<i>Number of people per 20-year generation</i>
AD 700–900	2,969	1,188–1,781
AD 900–1050	Unknown	Unknown
AD 1050–1100	695	1,112–1,668
AD 1100–1280	3,103	1,379–2,069

In the early decades of the AD 700s, the Upper San Juan region was inhabited by a local population characterized as having ceramics tempered with uncrushed sand and white wares decorated with organic paint. They were building residential pit structures that were typically circular in shape. Site layouts followed pan-regional norms, having a central residential pit structure backed by an arc of surface-level storage rooms arranged either as isolated rooms or as a single row of contiguous rooms.

By the mid-AD 700s, migrant groups originating from the Northern San Juan region to the west arrived in the upper Animas River portion of the Upper San Juan region. That these migrant populations had roots in the Northern San Juan is evident ceramically by their use of crushed rock temper and mineral paint and architecturally by the construction of rectangular pit structures—all of which are characteristics commonly attributed to populations of the Northern San Juan region. Slight ceramic manufacturing differences existed between these migrants and their relatives to the west. The migrant groups in the Upper San Juan used locally available rock tempering material instead of the andesite and diorite materials commonly used in the Northern San Juan region (Allison 2010). This preference was likely related to resource availability, as andesite and diorite are rare along the Animas River. The use of crushed rock temper suggests a continuation of the manufacturing tradition. They also differed in the selection of raw material used in the production of mineral paint. In the Northern San Juan it was common to use crushed iron or manganese minerals to create a matte mineral paint to decorate vessel surfaces. In the Upper San Juan, however, the Northern San Juan migrant potters employed crushed lead-bearing minerals, presumably galena, to create a glaze paint (Shepard 1939). Both iron and lead were locally available in the Upper San Juan region. However, lead-based glaze paints were being actively selected over the traditional iron and manganese matte paints. As discussed below, the availability of lead minerals along the upper Animas River might have been a motivating factor for the movement of migrants into the area.

Earlier interpretations of Upper San Juan ceramic developments have considered the presence of multiple temper and paint types as temporally distinct. The Navajo

Reservoir Project generated the first synthesis of Upper San Juan ceramic characteristics and considered uncrushed sand temper and organic and glaze mineral paints to occur during the AD 700s to mid-AD 800s followed by a transition to crushed rock temper and matte mineral paints (Dittert 1958; Eddy 1966). Based on Navajo Reservoir Project depictions of a temporal shift in ceramic traits, Richard H. Wilshusen and Scott G. Ortman suggest the replacement of earlier temper and paint types was the result of returning Upper San Juan migrants who had been residing in the large villages to the west and had assimilated to Northern San Juan norms of using crushed rock tempers and matte mineral paint (Wilshusen and Ortman 1999).

The temporal distinction between the use of sand and crushed rock tempers is no longer tenable, as both are known to be present in the Upper San Juan from at least the AD 700s (Allison 2010; Reed and Goff 2007). A review of 232 Upper San Juan ceramic assemblages, with comparable analyses of 112,212 sherds from both excavation and survey contexts (Simpson 2011), shows that both sand tempers and crushed rock tempers persist throughout the Upper San Juan occupation but vary according to site location by each side of the San Juan River (figure 15.1). North of the river, crushed rock tempers and mineral paints occur in high frequencies and remain important through time. South of the river, an opposite pattern is present, with sand temper and organic paint being dominant during the Rosa (AD 700–850) and Piedra (AD 850–950) phases, with an apparent drop-off during the Arboles phase (AD 950–1050). These dramatic decreases of the Arboles phase are likely due to the underrepresentation of sites from the south side of the river ($n = 2$). The Gallina phase (AD 1100–1280) ceramics compare favorably with trends between the Rosa and Piedra phases on the south side of the river, suggesting that the two intervening Arboles phase sites for this area are an anomaly and that uncrushed temper and organic paint continued in popularity.

These migrants came to occupy multiple communities within the Upper San Juan alongside local populations. Arguably, the densest areas of occupation were occurring along the upper Animas River in the area of modern-day Durango, Colorado. These communities were typically composed of clusters of residential hamlets with minimal levels of aggregation and short occupation spans of no more than a few generations. One exception is the Sacred Ridge site (5LP245), a small village of no more than 60 people with public architecture and which likely served as a central place for the otherwise semi-aggregated community (Chuipka 2009; Potter et al. 2012:65).

Undoubtedly, numerous contributing factors are causal in the migration of Northern San Juan migrant groups into the Upper San Juan, but only two of these will be considered here. As previously mentioned, the lead minerals required for the manufacturing of glaze-painted ceramics are available in the upper Animas River

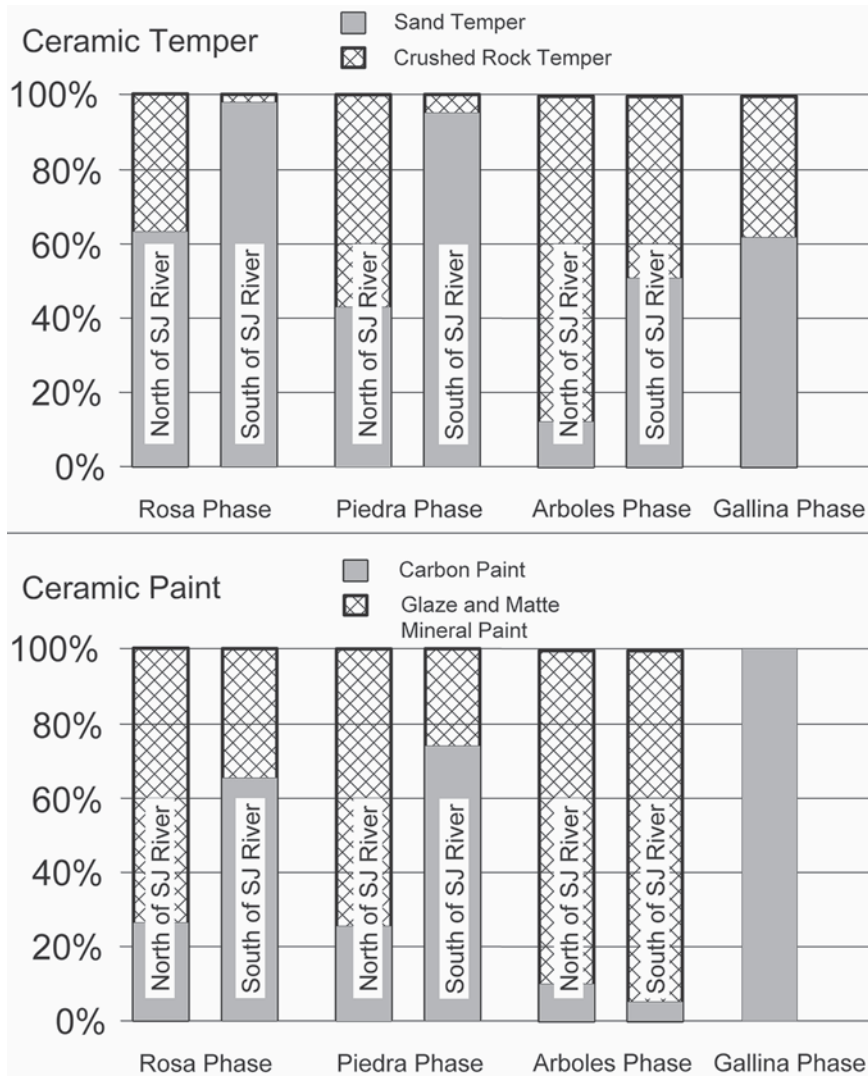


FIGURE 15.1. Dominant temper and paint types in the Upper San Juan.

area of the Upper San Juan region. This potentially important resource might have attracted Northern San Juan potters who were looking for alternatives to the more common iron- or manganese-based matte paints.

It is also possible that the choice of making glaze instead of matte mineral paints was related to the changing identity of the migrant groups. During the AD 750s

and 760s, about the same time that the migrants began to arrive in the Upper San Juan, significant social, cultural, and ideological changes were beginning to occur in the western portions of the Northern San Juan (Allison et al. 2012; Brew 1946; Martin 1939; Wilshusen et al. 2012). At a minimum, these changes included the development of large villages with up to 300 to 400 inhabitants, long linear room blocks housing multiple households, double-row surface structures with large residential rooms backed by smaller storage rooms, and the use of pit structures by multiple households for domestic and ritual activities that would become increasingly specialized ceremonial structures.

The significance of these changes could hardly be overstated, as they completely transformed the Northern San Juan region during the AD 700s and AD 800s and have been interpreted as providing part of the impetus for the later Chacoan system (Windes and Van Dyke 2012; Wilshusen and Van Dyke 2006). It is especially interesting then that such changes did not occur in the Upper San Juan. Instead, the patterns described for the AD 700s continue not only through the AD 800s but for as long as the Upper San Juan region is occupied. It is possible that migrant groups were moving out of the Northern San Juan ahead of the eastern spread of these changes and that the choice of using glaze paint instead of matte paint for decorating ceramics was part of the development of their identity that included resistance to the transformative pressures coming out of the Northern San Juan.

Early AD 800s to AD 900: Strengthening Identity

The near absence of dates after the AD 820s in the upper Animas area suggests the occupation in this area came to an end in the first decades of the AD 800s amidst violence, as evidenced at sites immediately south of Durango, Colorado. At Sacred Ridge this violence takes the form of extreme processing of multiple individuals (Potter and Chuijka 2010). These violent events near the end of the upper Animas River occupation might have been related to conflicts between populations in the Upper San Juan region and those to the west in the Northern San Juan region. However, Benjamin Bellorado (2013) has recently suggested that the violence at Sacred Ridge might also have been a local response to the ostentatious display of wealth at the site, a trait not common to any time in the Upper San Juan.

The depopulation of the upper Animas River area begins a pattern of movement away from the northwestern portions of the Upper San Juan to the east and south—coincidentally, also away from the Northern San Juan. That Upper San Juan and Northern San Juan relations were strained during the AD 800s is supported by the movement of La Plata River–area populations, who had Northern San Juan–style villages and architecture, to the west, away from Upper San Juan populations (Potter et al. 2012:57), and by the strengthening of the Upper San Juan identity, as

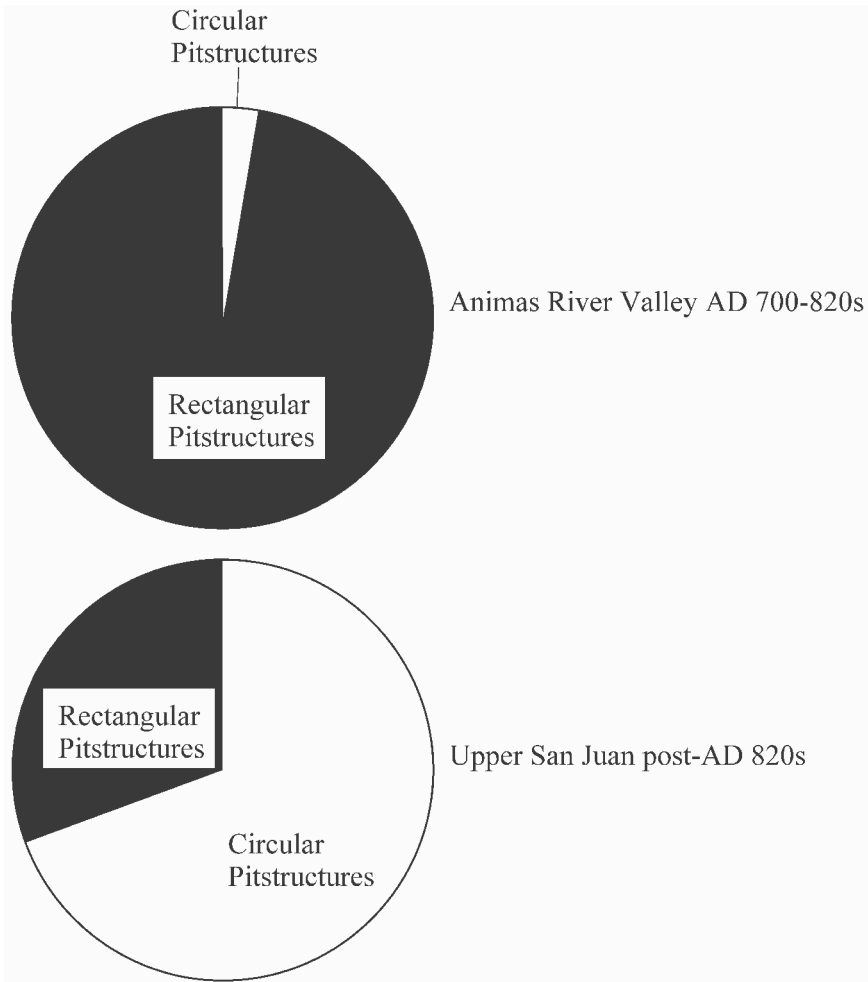


FIGURE 15.2. Proportional representation of pit structure shapes in the Upper San Juan.

the migrant and local groups began to move. In the upper Animas River area, it was common to find both circular (local) and rectangular (migrant) pit structures (figure 15.2). But as these mixed populations moved out of the area, rectangular-shaped pit structures were largely replaced by the circular form, which remains dominant throughout the rest of the occupation of the Upper San Juan.

Frank W. Eddy (1974) had previously offered environmental data to suggest that the movement of these Upper San Juan populations was related to climatic changes that caused the headward erosion of drainages through agricultural land.

These environmental changes, in Eddy's view, resulted in populations steadily moving upstream to the east and south. While it is possible that such environmental changes did occur and would have certainly played a role in where the Upper San Juan agriculturalists opted to live, they would have only been part of the larger complex reality of living in the Upper San Juan region.

AD 900s to Mid-AD 1000s: Diverging Identities

After the late AD 800s, the social and cultural conditions that resulted in a strong Upper San Juan group identity diminished due to the shift in energy and focus of the transformative social and cultural center away from the Northern San Juan region south toward Chaco Canyon (Wilshusen et al. 2012). The result of this shift created the social and physical space for a relaxing of the Upper San Juan identity between the AD 900s and the AD 1000s. Upper San Juan populations were still clearly identifiable when compared to other contemporary groups, but by about AD 1050, they had developed slightly different trajectories, as seen in architecture and ceramics in the Chimney Rock area, as will be discussed.

As reflected in table 15.1, minimum population estimates are difficult to establish for this period. This problem is, in part, attributable to the rarity of excavated sites from the tenth and early eleventh centuries as well as our uncertainty regarding settlement layout and structure. It has been suggested that the Upper San Juan might have been largely depopulated during these centuries, with populations moving to the west and southwest, into the Middle San Juan and Chaco regions (Chuipek et al. 2013; Potter et al. 2012; Wilshusen 2009). However, such large-scale movements of people out of the Upper San Juan are supported by negative evidence—namely, the absence of tree-ring dates within the Upper San Juan rather than by population fluctuations or material culture differences in the areas of the supposed destination. Given the issues with the data set for this time period and the lack of evidence for the arrival of migrants in adjacent areas, it is likely that earlier population levels persist within the Upper San Juan. The basis for this argument is elaborated here.

Based on known sites, there were fewer than 250 people estimated in the Middle San Juan region in the early Pueblo II (PII) period, when supposed Upper San Juan migrants would have arrived, and only around 500 people by the middle of the PII period (Brown et al. 2013). The area was not significantly occupied until the late AD 1000s, when there were more than 3,000 people in the Middle San Juan and well over 1,000 people in the Upper San Juan (Brown et al. 2013). If portions of Upper San Juan populations migrated into the Middle San Juan region, it would have been only a small proportion of the overall population and *not* a regional population shift. It is equally unlikely that Upper San Juan populations moved into the Chaco area to become part of the burgeoning Chacoan system in the AD 900s, after a century

and a half of resisting the Northern San Juan seeds of the Chacoan system. On the other hand, the construction of a Chacoan great house in the Upper San Juan in the late AD 1000s suggests at least a grudging acceptance of their presence. Perhaps the hope of the “Pax Chaco” allowed for the acceptance of such outside influence (LeBlanc 1999). That the majority of Upper San Juan populations remained within the region is also supported by the continuity of architecture and community and site layouts between earlier and later time periods. Had significant proportions of the population moved away during the AD 900s, they might be expected to return with cultural patterns more reminiscent of their host areas.

The difficulty of recognizing sites of the AD 900s and early and mid-AD 1000s in the Upper San Juan is related to several factors. Excavated Upper San Juan sites have a tendency to date chronometrically later than their ceramic assemblages would suggest, owing to the culturally conservative nature of the Upper San Juan and its slow rate of cultural change (Chuiпка and Fetterman 2013). This conservatism is coupled with the virtual absence of external stimulus created by the greater distance between the Upper San Juan and neighboring culture centers after the collapse of the Northern San Juan villages.

Mid-AD 1000s to AD 1100: Coalescence

By the mid-AD 1000s, there were at least 1,112 to 1,668 people per generation in the Upper San Juan, as estimated from residential structure counts obtained from NMCRIS and Compass archaeological site databases (table 15.1) and survey and excavation reports from the Chimney Rock area (Chuiпка et al. 2013; Eddy 1977). In the northern portion of the Upper San Juan, populations that had previously dispersed or were otherwise difficult to recognize archaeologically move into and cluster together in the Chimney Rock area along both sides of the Piedra River. These coalescing populations were likely drawn to this area to be close to what Nancy J. Malville (2004) calls “a location of high devotional expression.” Chimney Rock is known to have had multiple astronomical associations, not the least of which was the lunar standstill that occurs every 18.6 years. The significance of Chimney Rock as an observatory likely drew the attention of the Chacoans, who, in turn, established a multistory great house at the base of the Chimney Rock spires in AD 1076.

This movement into the Chimney Rock area brought together people that had been developing divergent cultural trajectories during the previous century and a half. This coalescence is observable on Stollsteimer Mesa, where different types of surface habitation structures had been previously interpreted as being temporally distinct (Roberts 1930). However, tree-ring dates from Stollsteimer Mesa sites and subsequent survey in the general Chimney Rock area suggest that the majority of the occupation was contemporaneous, dating to the second half of the AD 1000s.

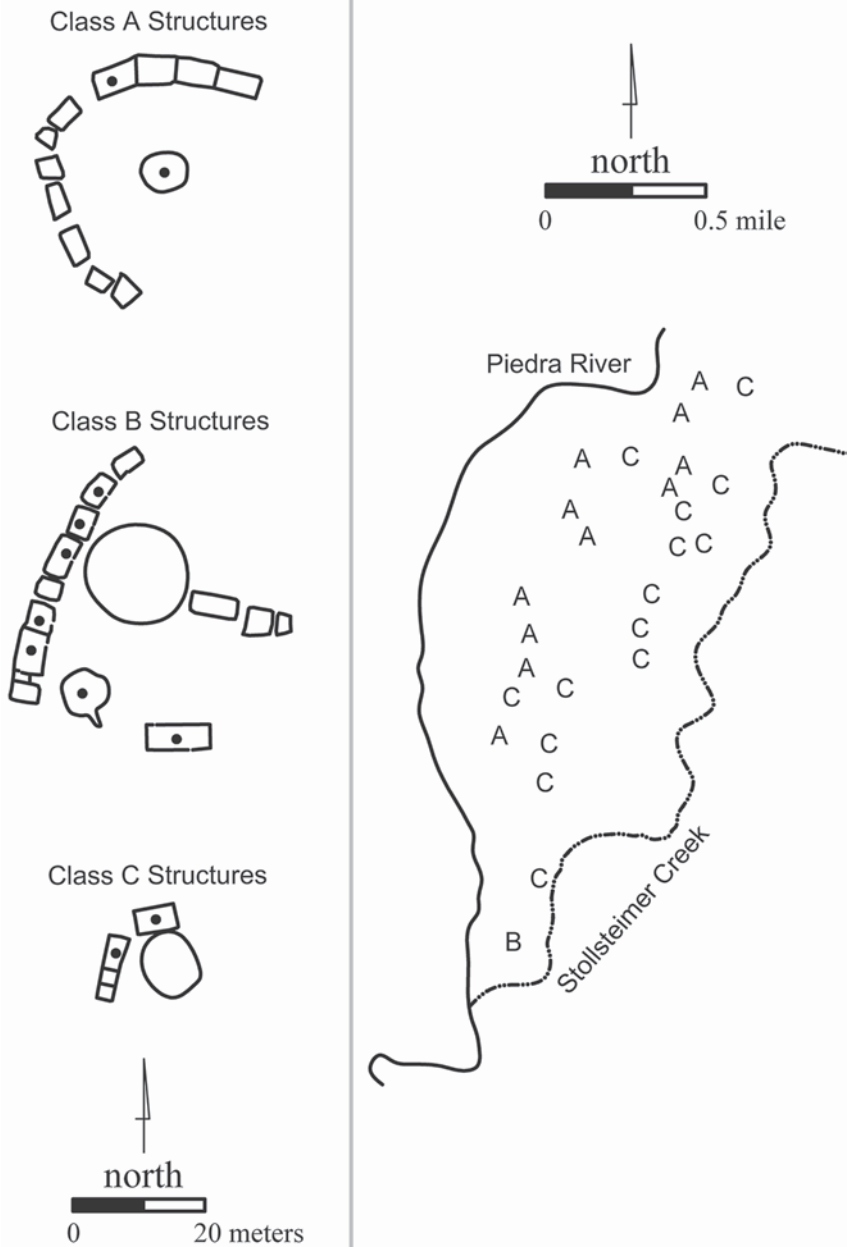


FIGURE 15.3. Class A, B, and C structures and their distribution on Stollsteimer Mesa.

Frank H. Roberts (1930) identified three classes of surface structures (A, B, and C) that he interpreted as sequential steps in architectural development (figure 15.3). The Class A and B sites are generally similar, with the primary difference being between the slanting jacal walls and long roof beams of the Class A structures and the vertical jacal walls and shorter roof beams of the Class B structures. The Class A and B sites were associated with slipped white ware ceramics but lacked corrugated vessels. The Class C sites are distinct in that they include a jacal residential surface room, with more substantially constructed storage rooms attached at one end, a structure type also documented during the Navajo Reservoir Project (Dittert and Eddy 1963). They also differ from the Class A and B sites in that, along with slipped white wares, these sites also contained corrugated ceramics.

The absence of corrugated ceramics from the Class A and B sites is certainly compelling evidence that they should predate the Class C structures. But non-cutting tree-ring dates published after Roberts's (1930) reporting of the excavations suggest that the Class A sites date sometime after AD 1011 (vv) when corrugated ceramics would have been available, had the site occupants elected to have them (Dean 1975). Additional evidence that these distinct sites might have been part of a contemporaneous occupation is found in their distribution (figure 15.3). The Class A structures cluster on the western portion of the mesa and the Class C structures on the east and south portions, with little apparent mixing. It is likely, then, that cultural diversity existed within the Chimney Rock area, although this does not necessarily imply they were ethnically unique. Instead, it might represent conservative and progressive elements within the general Upper San Juan identity (Chuiipka and Fetterman 2013).

Around the Chimney Rock cuesta itself, communities at lower elevations along the Piedra River were occupying villages with both residential pit structures and surface structures and with great kivas and gridded surface structures, reminiscent of later Gallina granaries. The higher elevation communities consist of thick-walled masonry residential surface structures that strongly mirror contemporaneous pit structures, as well as later Gallina structures, giving rise to being called "above ground pit structures" (Eddy 1977). These thick-walled structures are located exclusively on the upper portions of the cuesta in thin soils or on the sandstone bedrock, suggesting that they essentially were intended to be pit structures but were built in settings that did not permit subsurface construction.

The nature of the relations between the Upper San Juan locals and the Chacoan system, represented by Chimney Rock Pueblo, is still debatable. Whether the Chacoans were acting as peaceful missionaries or imperialists or some combination of the two is unknown, but the initial interactions between the two groups appear to have been friendly (Malville 2004). This might not have been the case

at the end of the occupation of the Chimney Rock area. While the only suspected case of violence comes from an unburied and thoroughly burnt body from a Class C structure (Roberts 1930:59), other less-conclusive evidence exists. This includes the nearly ubiquitous presence of burned structures from the AD 1000s, although the burning of structures might be related to closing activities at the end of the area's occupation (Wilshusen 1986). Also of interest is the mention of cremations along the margins of the upper cuesta and the Piedra River (Jeançon 1922; Roberts 1930). Cremation of the dead is not a recognized burial practice in the Upper San Juan for any time period, and its presence in the Chimney Rock area is suspect. It is possible that the burned bodies represent individuals killed and burned in the burnt structures that were later retrieved and placed within middens, a common Upper San Juan burial location.

Regardless of how the Upper San Juan and Chacoan relations came to an end, the result is the large-scale movement of people away from the northern portions of the Upper San Juan to the south side of the San Juan River. This movement probably occurred in the first decade of the AD 1100s. This is somewhat earlier than the often-cited end date of AD 1125. The later date, however, was based on assumptions of what ceramic types might be expected to be present, had the occupation extended that late (Eddy 1977). Instead, it might be that the occupation ended well before AD 1125. Chimney Rock Pueblo was built during a period of lunar standstills in AD 1076 and rebuilt during the next period of standstills in AD 1093. This pattern might suggest that additional construction activities could be expected during the next episode of lunar standstills around AD 1111. Because there are no tree-ring dates anywhere in the Chimney Rock area dating after AD 1093, the area might have been depopulated by the first decade of the AD 1100s.

AD 1100s to Late AD 1200s: Solidifying Upper San Juan Identity and the Collapse

Following the collapse of the short-lived Upper San Juan and Chacoan relations at Chimney Rock and the subsequent shift of northern Upper San Juan populations to the south, the entirety of Upper San Juan inhabitants were living south of the San Juan River, extending as far south as the Jemez Mountains. At least 1,379 to 2,069 people were living in the Upper San Juan region between AD 1100 and the late AD 1200s (table 15.1). These recently coalesced Upper San Juan populations soon developed the highly homogenous traits and isolationist nature of the Gallina phase (Simpson 2008). The inspiration for the strengthening of the Upper San Juan identity to a degree even beyond that of the AD 700s and AD 800s was surely derived from the cessation of relations with the evolving Chacoan system, who themselves were about to experience a power and population shift back to the north (Reed 2008a).

TABLE 15.2. Percentages of corrugated sherds in gray ware assemblages

<i>Site</i>	<i>Corrugated sherds in utility assemblages</i>
Chimney Rock area sites	
5AA87	55%
5AA88	60%
5AA98	64%
5AA106	70%
5AA246	51%
5AA249	52%
LA 4103	55%
LA 4104	76%
Gallina area sites	
LA 11843	0%
LA 11850	0%
LA 14318	2%
LA 57398	0%

The Gallina identity saw the continuation of some earlier traits, such as the dual ceramic manufacturing traditions differentiated by the use of crushed rock or sand tempers, the co-occurrence of residential pit structures and surface structures, and structure types. Other traits, such as corrugated ceramics and mineral paint, were dropped from the cultural inventory. There are few well-dated sites reported for this period of initial Gallina identity formation. One example, LA 14318, comes from the northern portions of the Gallina area and possibly dates to the AD 1100s (Knight 1990; Stuart and Gauthier 1981). LA 14318 was a multi-residence settlement that contained over seven structures clearly built within Gallina norms of residential architecture (Knight 1990). However, the site has corrugated ceramics, which is unusual for later Gallina sites. The small quantity of corrugated ceramics at LA 14318—only 2 percent of the gray ware assemblage—is a fraction of what might be expected from earlier sites north of the San Juan River but is an appreciable amount when compared with other Gallina sites that report no corrugated ceramics (table 15.2). The presence of corrugated ceramics at LA 14318 might suggest that, while greatly reduced in frequency, earlier Upper San Juan traits such as corrugated ceramics and mineral paint could occur in early Gallina sites. It should also be mentioned that corrugated ceramics also occur at Gallina sites on the southern periphery of the Gallina occupation but

in all likelihood were trade items from populations that had roots in the Cibola cultural tradition (Wilson 1994).

By the late AD 1200s, the majority of Gallina populations were living along both sides of the Continental Divide in what was the southern portion of the traditionally defined Gallina area. The Gallina had inhabited this southern area as early as AD 1106 and potentially earlier (Mera 1938). These early Gallina populations are likely to represent the poorly understood Upper San Juan populations that are suspected to have begun moving upstream to the south by as early as AD 850 (Eddy 1974). Gallina people who had previously occupied the northern portion of the Gallina area apparently moved south, joining existing Gallina populations. The scale and motivations of this movement are uncertain, but it resulted in high site density along the Continental Divide. This is particularly true in the general area of Llaves, New Mexico, where residential structure densities were as high as seventeen per square mile (Simpson 2010).

The Gallina occupation of the region appears to come to an end in the late AD 1200s, based on the lack of tree-ring dates later than the AD 1270s (Borck 2012). It had long been speculated that the Gallina phase ended in a dramatic episode of violence (Constan 2011; Stanerson 2012). Although the source of this violence is still arguable, it is likely that it was perpetrated by non-Gallina groups, possibly even by Northern San Juan migrants who were moving toward the Rio Grande and Chama drainages (Borck 2012). Perhaps the centuries-old tensions between the inhabitants of the Upper San Juan and Northern San Juan regions culminated in the violence known to have occurred in the Gallina area.

After this episode of violence near the end of the Gallina occupation of the Upper San Juan, it is difficult to trace their movement out of the area. It has been often suggested that the Gallina moved farther south to become the modern-day inhabitants of Jemez Pueblo. Evidence of this movement is based on minor architectural attributes and osteological comparisons (Mackey 1977, 1982; Reiter 1938; Wiseman 2007). It is not entirely clear that the above scenario is correct, as both archaeologists and the Pueblo of Jemez have expressed doubts about the connection (Borck 2012; Elliott 1998; Roberts 1996). It is likely, then, that survivors of the violence of the late AD 1200s dispersed and were absorbed by the large emerging pueblos of the AD 1300s, including those in the Jemez area. The inability to recognize these Gallina descendants archaeologically as a distinct cultural group within the large pueblos of the AD 1300s might suggest that they were absorbed as small family groups that would have been more easily assimilated, as opposed to larger migrant groups who might have retained recognizable ethnic signatures (Ortman and Cameron 2011).

CONCLUSIONS

The overriding narrative of this chapter has been that both Upper San Juan population movement and fluctuations in identity are closely related to external stimuli. It is essential to have an understanding of the social and cultural contexts of the Upper San Juan inhabitants to begin to address the causal factors in the cultural changes in the area. For the most part, the Upper San Juan patterns appear to have been greatly influenced by the dramatic changes occurring in the Northern San Juan during the AD 700s and AD 800s and by the related Chacoan system of the late AD 1000s. Instead of these substantial social and cultural phenomena driving similar changes within the Upper San Juan through assimilation or emulation, they appear to have fostered a conservative attitude and built an identity in apparent opposition to these changes.

Beginning in the mid-AD 700s, populations of the Northern San Juan begin migrating east into the Upper San Juan looking to capitalize on the lead resource in the Upper San Juan for the production of glaze mineral paint, to escape the changes commencing in the western portions of the Northern San Juan, or both. This movement probably consisted of family or lineage groups moving over a short period of time. The integration of these migrants into the Upper San Juan area appears to have resulted in occasional but extreme bouts of violence, but eventually leading to a more peaceful coexistence. After the early AD 800s, the pattern of movement no longer entails the movement of people into different cultural environments but rather a movement across the uncontested Upper San Juan landscape, with earlier areas of occupation being left depopulated in favor of new locales in unoccupied areas.

The Upper San Juan identity of the AD 700s and AD 800s, with its roots in resistance to the Northern San Juan social phenomenon, begins to change after the late AD 800s. This occurred as Northern San Juan populations began to disperse and as the strength of the social changes shifted south to become part of the Chacoan system, likely with Cibolan populations that were already in the area and moving north from areas farther south. With the pressure off and no nearby threat to resist, the Upper San Juan identity begins to diverge and population movements appear to have slowed, along with some degree of intra-regional dispersal.

It is only when external pressures, represented by the Chacoan presence at Chimney Rock Pueblo, again emerge in the mid- to late AD 1000s that the Upper San Juan populations move back into densely aggregated communities. This acceptance of an outside influence inside the Upper San Juan region collapses within a generation's time. This collapse of relations results in a large-scale movement of multiple communities from north of the San Juan River to south of the river and the subsequent development of a cohesive and homogenous identity.

This strong identity, again based on resistance to external pressures coming from the west, is maintained for nearly two centuries. Widespread violence in the southern portions of the Upper San Juan region in the late AD 1200s seems to have resulted in dilution of the Upper San Juan identity, as clear cultural descendants are difficult to identify. It is likely that the Upper San Juan populations that did not succumb to the violence of the late AD 1200s became part of the populations streaming into the Jemez, Rio Grande, and Chama River areas. This diaspora of survivors apparently resulted in new forms of identity that concealed their Upper San Juan roots.

It is expected that portions of the model presented here will undergo refinements as our knowledge of the Upper San Juan continues to expand, just as it is a refinement of past models (Eddy 1966, 1974; Wilshusen and Ortman 1999). That the Upper San Juan region promises cultural complexity rivaling more thoroughly researched areas should be clear. The recognition that regions once thought to have been marginal to major cultural areas might instead have been actively resisting the prevalent trends of the time should also be applicable in other parts of the Southwest and beyond.

Movement of People and Pots in the Upper Gila Region of the American Southwest

DEBORAH L. HUNTLEY, JEFFERY J. CLARK, AND MARY F. OWNBY

A major goal of the chapters in this book that deal with movement is to unpack the assumptions associated with observed patterns in the distributions of archaeological materials on the landscape. As Deborah L. Huntley discusses in her introduction to the study of movement, distributions of objects are inextricably linked to distributions of people, and the former are often used to infer the latter (see also Ramenofsky and Herhahn, this volume). The causes of object distributions are rooted in the social processes of migration, exchange, and emulation. While not mutually exclusive phenomena, these three processes nonetheless can be differentiated in the archaeological record (e.g., Clark 2001; Duff 2002; Eckert 2008; Lyons 2003; Neuzil 2008). In this chapter we examine the interaction of these three processes in the late precontact (post-AD 1300)¹ Upper Gila and Mimbres regions of southwestern New Mexico and southeastern Arizona (map 16.1). As we discuss, divergent yet overlapping social networks and population mixing led to the development of two community forms in the southern Southwest: *communities in diaspora* and *coalescent communities*. Simply put, a community in diaspora shares a culture but is spatially dispersed (Clifford 1994). A coalescent community shares a place but is culturally diverse (Hill et al. 2004). As we discuss below, the former is associated with Ancestral Pueblo immigrants in the southern Southwest who maintained long-distance social connections, while the latter is a somewhat later development encompassing both immigrants and local populations who participated in the Salado phenomenon.



MAP 16.1. Southeastern Arizona and southwestern New Mexico, showing locations of places mentioned in the text.

We begin by defining our concept of Salado identity and outlining models of late prehistoric community organization based on previous research in southeastern Arizona. Next, we review existing data on population trends, ceramic type distributions, and obsidian circulation for the Upper Gila/Mimbres region, placing the case study within a larger context of population reorganization in the late prehistoric southern Southwest. Finally, we present new data on ceramic production and circulation that highlight local and regional processes of migration, community development, and identity formation.

THE SALADO PHENOMENON AND MODELS OF COMMUNITY ORGANIZATION

The enigmatic Salado material culture pattern has both vexed and intrigued archaeologists for decades (Crown 1994; Dean 2000b; Franklin 1980; Gladwin and Gladwin 1935; Haury 1945; Nelson and LeBlanc 1986). Characterized by elaborate and technologically distinctive polychrome pottery (called Salado Polychrome or

Roosevelt Red Ware; see discussion in Lyons 2012:213–14), as well as a diverse suite of architectural attributes, Salado material culture emerged during the major demographic upheaval that began in the mid-thirteenth century. Previous research suggests that Roosevelt Red Ware production was linked to Ancestral Pueblo immigrants from the Kayenta region of northeastern Arizona and their descendants (Clark and Lyons 2012; Crown 1994; Lyons 2003; Lyons and Clark 2012; Lyons and Lindsay 2006).

Although specific interpretations differ, many scholars associate the popularity of Roosevelt Red Ware with the spread of new ideas and practices—religious or otherwise (e.g., Crown 1994; Lyons and Clark 2012; VanPool et al. 2006; for alternative viewpoints, see McGuire 1991; Rice 1990; Wilcox 1987). Archaeology Southwest researchers use the term *Salado* to describe a culturally diverse group of people (both resident populations and immigrants) brought together during a time of crisis, who shared an inclusive ideology. In the context of this inclusive ideology, Salado-affiliated groups developed a hybridized cultural identity that resulted from extended contact between Kayenta immigrants and local Hohokam and Mogollon groups in the southern Southwest (Clark et al. 2013). This contact produced different types of communities that not only provided security and social harmony in times of demographic upheaval but also facilitated the movement of people, ideas, and goods across long distances.

Archaeology Southwest's research in the Lower San Pedro Valley (Clark and Lyons 2012) showed that while thirteenth-century Kayenta immigrants to this area were a minority, they maintained key elements of their cultural heritage (e.g., Lyons and Lindsay 2006) for more than a century after resettlement. We believe that their strong cultural influence derived from the enduring community in diaspora that they formed. Communities in diaspora are unlike traditional communities (Fish et al. 1992; Murdock 1949; Rohn 1971; Wills and Leonard 1994) because they are not defined by spatial proximity. Communities in diaspora dispersed by migration develop trans-regional networks based on shared ideologies and identities (Clifford 1994; Safran 1991, 1999).

Kayenta communities in diaspora can be identified archaeologically in several ways. A principle hallmark of such communities is the presence of Maverick Mountain Series pottery (Lindsay 1987, 1992; Lyons 2003; Neuzil and Lyons 2006). This group of types, or series,² was named for the late thirteenth-century Maverick Mountain phase Kayenta occupation at Point of Pines Ruin, Arizona (Breternitz et al. 1957; Lindsay 1987), and is distributed throughout much of central and southwestern Arizona and southwestern New Mexico (figure 16.1a). At Point of Pines and elsewhere, Maverick Mountain Series vessels are essentially Kayenta and Tusayan decorated pottery types made using local materials (e.g., Lyons 2012; Neuzil 2008).

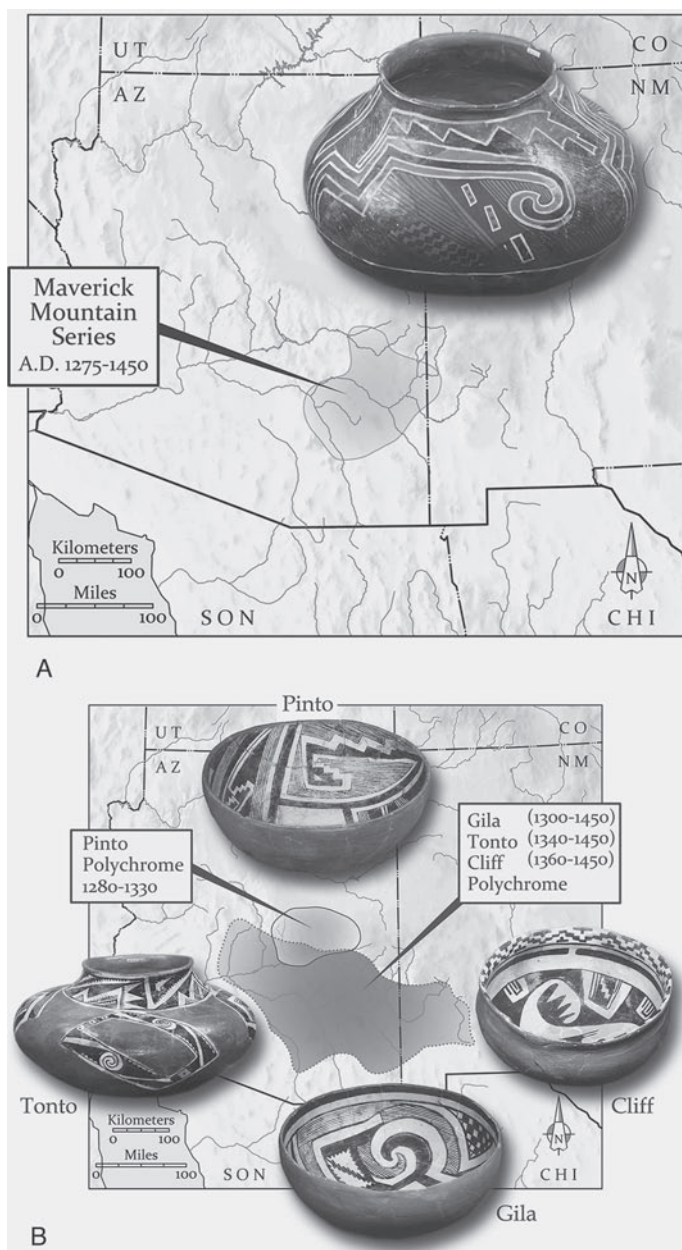


FIGURE 16.1. Ceramic distributions based on the Southwest Social Networks Database (Mills et al. 2013): (a) Maverick Mountain Series pottery and (b) Salado Polychrome pottery.

The presence of a unique and idiosyncratic vessel form known as the perforated plate (Lyons and Lindsay 2006) in assemblages containing Maverick Mountain Series pottery is viewed as another indicator of Kayenta presence in the southern Southwest (Crown 1994; Lyons 2003, 2012; Lyons and Clark 2012; Lyons and Lindsay 2006; Mills 1998). Perforated plates have a distinctive shallow platter form, typically with perforations (made when the clay was still plastic) around the rim (Lyons 2003). They have been interpreted as potter's tools, either slow wheels or base molds (Christenson 1994; Lyons and Lindsay 2006). Before the late thirteenth century, the distribution of perforated plates was largely restricted to the Kayenta homeland in northeast Arizona. This unique vessel form was found throughout much of eastern Arizona after the Kayenta region was depopulated as well as in southern Utah and southwestern New Mexico (Lyons and Clark 2012:figure 3.5). Like Maverick Mountain Series vessels, at nearly every site where they have been found, perforated plates were made with locally available materials (Lyons 2003, 2012; Neuzil 2008).

Archaeology Southwest's work in the Lower San Pedro Valley also revealed a tenfold increase in exotic obsidian consumption shortly after the arrival of Kayenta immigrants in the late thirteenth century (Hill et al. 2004; Clark and Lyons 2012). Kayenta enclaves had considerably higher obsidian densities than local settlements, and all obsidian at the enclaves was from the Upper Gila region (largely the Mule Creek source), as determined by X-ray fluorescence analysis (Shackley and Gallop 2012). This pattern suggested a connection with other Kayenta immigrants in the Upper Gila region, especially near Mule Creek, that facilitated access to this obsidian by San Pedro Kayenta immigrants, who then traded it down the line to local groups. This dramatic increase in the early fourteenth century was not limited to the San Pedro Valley but occurred throughout much of the southern Southwest. Mule Creek was the dominant obsidian source in the San Pedro Valley and the Safford Basin and was also present in substantial quantities in the Tucson Basin and Tonto Basin. Some of this material was traded as far west as Casa Grande.

There are also architectural hallmarks for the presence of northern Pueblo immigrants in the southern Southwest. These include shaped stone block masonry architecture, in contrast to adobe or cobble and adobe architecture used by the Hohokam and other southern groups (Clark 2001; Clark et al. 2012; Di Peso 1958), slab-lined entry boxes (Lindsay et al. 1968; Lyons 2003), and distinctive kiva forms (Clark and Lyons 2012; Di Peso 1958; Gerald 1975; Haury 1945; 1958; Neuzil 2008; Woodson 1999). In many cases immigrants moved in with or settled near existing groups with very different histories. In the Lower San Pedro Valley and in the Safford Basin there are spatially distinct immigrant enclaves that contrast with local archaeological signatures (Clark 2001; Clark and Lyons 2012; Clark et al.

2012:373; Clark et al. 2013; Di Peso 1958; Lindsay 1987; Lyons 2003; Neuzil 2008; Woodson 1999).

Over time, cooperative and competitive interactions between Kayenta and host populations led to striking transformations in settlement organization, social and trade networks, and especially ideology (Crown 1994). Under some circumstances Kayenta immigrants and their descendants found ways to coexist with local groups in multiethnic settlements we define as coalescent communities (Hill et al. 2004). In contrast to communities in diaspora, which connect groups scattered by migration based on real or imagined shared cultural heritage (Anderson 2006; Boyarin and Boyarin 1993; Clifford 1994), coalescent communities integrate diverse but spatially proximal residents via inclusive and interconnected economies, ideologies, and political institutions (Adams 1991; Crown 1994; Kowalewski 2007). Coalescent communities are characterized by multiculturalism and variable interregional connections. We argue that Salado identity served to unite diverse populations within coalescent communities, using a new ideology to mediate conflict between groups with divergent histories (Clark and Lyons 2012; Clark and Laumbach 2011; Crown 1994; Lyons et al. 2008).

Perhaps the most visible hallmark of Salado coalescent communities was Roosevelt Red Ware, which appeared beginning around AD 1280 in parts of southeastern Arizona (Crown 1994; Mills and Herr 1999; Zedeño 1994). While Roosevelt Red Ware and Maverick Mountain Series types share a basic color scheme and certain design elements, the former are decorated with black organic paint rather than black manganese-rich mineral paint used in the latter. Roosevelt Red Ware has a much wider distribution than Maverick Mountain Series pottery (figure 16.1b; see also Crown 1994:figure 1.1). Numerous chemical compositional and mineralogical sourcing studies indicate that Roosevelt Red Ware was made in nearly every southwestern river valley south of the Hopi Mesas (Crown 1994; Crown and Bishop 1991; Danson and Wallace 1956; Duff 2002; Hill 1998; Lightfoot and Jewett 1984; Lyons 2003, 2012; Martin and Rinaldo 1960; Mills et al. 1999; Neuzil 2008; Ownby et al. 2014; Simon et al. 1998; Stinson 1996; Zedeño 1994). Technological and iconographic similarities between Roosevelt Red Ware and Kayenta pottery suggest that the former was strongly influenced by immigrant ceramic traditions (Crown 1994; Lyons 2003; Lyons and Clark 2012). The presence of perforated plates at many fourteenth- through fifteenth-century sites with relatively large quantities of Roosevelt Red Ware is further evidence of this connection. Moreover, in the Lower San Pedro Valley, the Safford Basin, and the Lower Salt Valley, petrographic analysis pinpoints Roosevelt Red Ware production to communities that included Kayenta immigrants and their descendants (Lyons 2012).

We believe that the production and distribution of Roosevelt Red Ware tracks the development and spread of Salado ideology. Considering the strong stylistic and technological connections between Roosevelt Red Ware and Ancestral Puebloan—especially Kayenta—ceramic traditions, as well as provenance studies that suggest that Kayenta enclaves were the first producers, a strong argument can be made that Salado ideology was developed by these immigrants and their descendants. The rapid and widespread distribution of Roosevelt Red Ware—especially Gila Polychrome and later types—and the demise of local decorated wares (e.g., Middle Gila Buff Ware) indicates this ideology was socially contagious and rapidly spread to local groups.

Roosevelt Red Ware types are distinguished by their different decorative configurations and styles, which varied through time but were relatively homogeneous over a large area until the late fourteenth and early fifteenth centuries (Lyons and Clark 2012:table 3.1; Crown 1994; Neuzil and Lyons 2006). Based on their large size, high frequency of exterior decoration, use of specific icons (especially horned or plumed serpents), and discard patterns, Patricia L. Crown (1994:57) suggested that late (post-AD 1350) Roosevelt Red Ware bowls were increasingly used for feasting. Crown (1994) found that very large bowls were virtually absent from burials, suggesting that such vessels were not associated with individuals but with groups. More recent research using the refined Roosevelt Red Ware typology (Lyons 2004; Neuzil and Lyons 2006) identified changes in the maximum diameters of late Roosevelt Red Ware types through time. On later vessels, interior painted decorations were moved upward to the area between the rim and the “maximum fill line,” where participants could still observe them when the vessel was full (Lyons et al. 2011). A similar change in the size and placement of symbolically charged painted designs on the exteriors of late vessels has been interpreted as emblematic expression intended for social groups of increasing size (Mills 2007; Van Keuren 2004).

Unlike the architectural hallmarks of Kayenta migrant enclaves (entry boxes and kiva forms), architectural traditions linked with multiethnic Salado occupations varied substantially across space and even within regions (Lindsay and Jennings 1968; Nelson and LeBlanc 1986). Cobble and adobe architecture was common, but shaped block masonry also continued. In some areas open compounds were the standard residential unit (e.g., Tucson Basin) while in other regions, nucleated, multi-room block pueblos were the norm (e.g., Cliff Valley). Some regions contained roughly equal numbers of both forms or changed from compounds to room blocks through time (e.g., Safford Basin, Tonto Basin).

To summarize, Kayenta communities in diaspora in the southern Southwest can be identified by distinctive artifacts—decorated ceramics and perforated plates used as pottery making tools—as well as by distinctive architectural features such

as entry boxes. Distributions of these items (combined with provenance analyses) are best explained by the movement of people who made them rather than by widespread exchange or emulation. In contrast, obsidian from preferred sources appears to have been circulated widely among Kayenta-affiliated communities in diaspora, a pattern that apparently held for coalescent communities as well. As we conceptualize them, however, coalescent communities were less concerned with the long-distance movement of goods and more focused on localized processes of integration after migration. They were characterized by local diversity that was crosscut by participation in new religious practices initiated by immigrant groups and the adoption of new all-encompassing identities, as reflected in Roosevelt Red Ware (Clark et al. 2013). In some places communities in diaspora and coalescent communities existed simultaneously, both complementing and contrasting with one another. This provided an organizational flexibility that allowed people to participate in both community types, using social networks to their advantage in different contexts. This flexibility allowed the Kayenta to remain a potent minority in the southern Southwest for more than a century.

UPPER GILA/MIMBRES VALLEY STUDY AREA

The Upper Gila/Mimbres area (see map 16.1) is an ideal region to compare and contrast Kayenta migration and the development of Salado ideology with the better-known examples from the Hohokam region in southern Arizona. Here we have evidence for the movement of people and objects, as well as the transmission of ideas, over an extensive geographic area that until at least the mid-twelfth century is associated with the Mimbres Mogollon. Several lines of evidence—pottery distributions, obsidian sourcing, and ceramic production and distribution data—allow us to begin to disentangle the complex and intersecting relationships among these three variables during the thirteenth through fifteenth centuries. We argue that people from northeastern Arizona migrated hundreds of kilometers to various locales in the Upper Gila/Mimbres area during the late thirteenth century, much as they did to places like the Safford Basin and the San Pedro Valley in southern Arizona. In many instances immigrant and local populations eventually formed large, aggregated coalescent communities that were integrated by the inclusive Salado identity.

LARGE-SCALE POPULATION MOVEMENT AND REGIONAL SETTLEMENT PATTERNS

Previous demographic analyses (Hill et al. 2004) show more than one thousand years of sustained population growth in the Southwest, a brief stasis, and, beginning

in the early 1300s, gradual decline in overall population that accelerates through time. This population decline is most dramatic in northeastern Arizona and northwestern New Mexico (including the Kayenta and San Juan regions). At the same time as population declined in these areas, population increased in portions of the southern Southwest, the Rio Grande region, and the Upper Gila region. J. Brett Hill and colleagues demonstrate that *in situ* population growth alone cannot account for this population redistribution and that population decline in the north corresponds with population growth in the south (Hill et al. 2004). Based on a large body of distributional data (Hill et al. 2004; Mills et al. 2013), we argue that one archaeologically visible migration stream funneled people from the northern to the southern Southwest (separated roughly by the Mogollon Rim and Mogollon Mountains; see map 16.1) (see also Haury 1958:figure 1). Over a period of a few generations, groups of immigrants relocated to the southern Southwest, where they encountered large and established Hohokam irrigation communities in southern Arizona (Clark and Lyons 2012; Di Peso 1958; Haury 1945; Lindsay 1987; Lyons 2003; Lyons et al. 2011) and smaller post-Classic Mimbres and Ancestral Pueblo populations in southwestern New Mexico (Dungan et al. 2012; Huntley et al. 2010). By the end of the fourteenth century, communities across the southern Southwest experienced a demographic crisis that resulted in the widespread depopulation of the region by the mid-fifteenth century (Hill et al. 2004; Lyons et al. 2011).

The Upper Gila/Mimbres region is one of the few areas in the southern Southwest where relatively large populations remained until possibly the mid-fifteenth century. This area was part of the Mimbres sphere until the mid-twelfth century, as evidenced by masonry pueblos, kivas, and Mimbres pottery (Lekson 1990). Previous research had Mimbres populations leaving the area between 1130 and 1150, after which time there was an occupational hiatus (Fitting 1972; Lekson 2002).³ During the thirteenth century, small settlements attributed to the poorly documented Black Mountain phase were occupied throughout the region (Blake et al. 1986; Creel 1999; see also Nelson and LeBlanc 1986). At the same time, the southern edge of the Tularosa horizon (Lekson 1996), centered in west central New Mexico and east central Arizona, approached the far northern periphery of the study area. On the whole, however, thirteenth-century settlements in the Upper Gila/Mimbres were small and dispersed compared with the earlier large and aggregated room blocks of the Mimbres Classic period. Hence, we initially hypothesized that thirteenth-century Kayenta immigrant groups entered a relatively empty frontier where they sustained their culture and religion in relative isolation, unlike their relations in the heavily populated Hohokam area to the west.

Previous researchers reported conspicuous late occupations in the Cliff Valley (Lekson 2002; Mills and Mills 1972; Wallace 1998), leading to the definition of the

fourteenth- and early fifteenth-century Cliff phase. There is also evidence for continued occupation or reoccupation of many former Classic Mimbres sites throughout the Mimbres Valley (Nelson and LeBlanc 1986; Kroulek 2011). Late sites have multiple room blocks and irregular layouts, suggesting rapid growth through immigration. They also tend to be relatively large (100-plus rooms) compared with Mimbres, Black Mountain, and Tularosa phase pueblos, but smaller settlements are also known (e.g., Dutch Ruin in the Redrock Valley, see Lekson 2002:62–63). Construction is commonly adobe with *cimiento* (basal upright cobble) reinforcement, although masonry architecture is found at a few sites (Lekson 2002:4).

A few tree-ring samples from Kwilleylekia and Ormand Village (see map 16.1) dating to the mid- to late 1300s are the latest evidence for precontact occupation in the region (Robinson and Cameron 1991:23; Wallace 1998:412). The Upper Gila/Mimbres study area was most likely abandoned in the mid-fifteenth century, when populations may have joined communities with whom they had existing ties, including those in the Zuni, Hopi, and Chihuahua regions.

Upper Gila/Mimbres Ceramic Distributions

With a few notable exceptions (e.g., Lekson 2002; Nelson and LeBlanc 1986; Putsavage 2011, 2013; Kroulek 2011), post-AD 1300 Upper Gila/Mimbres sites have been investigated by avocational archaeologists such as Jack and Vera Mills (Mills and Mills 1969, 1972) and “Red” Ellison (Kwilleylekia) or as part of salvage operations (e.g., Hammack et al. 1966; see also Wallace 1998). For this reason, many collections were not obtained using modern excavation methods, nor were they studied using the most current analytical techniques. As a result, we have only a general sense of the range of thirteenth- through fifteenth-century ceramic types present at many sites. As part of our Upper Gila/Mimbres research, we investigated many of these collections and also conducted surface tabulations and/or test excavations at five Upper Gila/Mimbres sites with Cliff phase components. Table 16.1 summarizes information for Kayenta immigrant and Salado ceramic types present at various sites within the Upper Gila/Mimbres study area. To compile this table we used published reports where available and, in some cases, reanalyzed existing museum collections, mainly to check for late regional Roosevelt Red Ware types that only recently have been consistently differentiated from Gila Polychrome and Tonto Polychrome (Neuzil and Lyons 2006; Lyons and Clark 2012). Because we do not have systematic counts for all sites, we simply present presence/absence data. Note that ceramic assemblages from Upper Gila/Mimbres region sites also commonly contain earlier Classic Mimbres ceramics as well as low frequencies of later, nonlocal decorated types such as Cibola White Ware, White Mountain Red Ware, Playas Red Ware, and El Paso Polychrome.

TABLE 16.1. Maverick Mountain Series (MMS), Roosevelt Red Ware (RRW), and perforated plates at Upper Gila/Mimbres sites

<i>Area</i>	<i>Site</i>	<i>Site type</i> ¹	<i>MMS</i>	<i>Gila Polychrome</i>	<i>Cliff Polychrome</i>	<i>Late RRW type</i> ²	<i>Perforated plates</i>	<i>References</i>
Mule Creek	3-Up	Large pueblo	Present	Present	Present	Present	Present	Huntley et al. 2014
	Gamalstad	Small pueblo (?)	Present	Present ³	Present ³	Present ³	Present	Huntley et al. 2014
	Dutch Ruin	Large pueblo	Present	Present	Present	Present	Present	Lekson 2002
	Redrock Valley	Large pueblo	Present	Present	Present	Absent ⁴	Absent ⁴	Lekson 2002
Cliff Valley and north	LA 39035	Large pueblo	Present	Present	Present	Present	Absent	Hammack et al. 1966; Wallace 1998
	Ormand Village	Large pueblo	Present	Present	Present	Present	Present	Mills and Mills 1972; Huntley and Aragon 2014
Dinwiddie		Large pueblo	Present	Present	Present	Present	Present	Huntley, field notes, 2010
	Lichty's	Small pueblo (?)	Present	Present	Present	Absent ⁴	Present	Di Peso 1981; Kwilleylekia museum brochure
	Kwilleylekia	Large pueblo	Unknown	Unknown	Unknown	Present	Present	Lekson 2002
Villarreal II		Small pueblo	Present	Present	Unknown	Absent	Absent	McKenna and Bradford 1989; Huntley 2012
	TJ Ruin	Small pueblo	Absent ⁴	Present	Absent ⁴	Absent ⁴	Absent ⁴	Nelson and LeBlanc 1986
	Janss	Large pueblo	Absent	Present	Present	Absent	Absent	Nelson and LeBlanc 1986
Mimbres	Stailley	Small pueblo	Absent	Present	Absent	Absent	Absent	Nelson and LeBlanc 1986
	Disert	Large pueblo	Absent	Present	Present	Absent	Absent	Nelson and LeBlanc 1986
	Black Mountain	Large pueblo	Present	Present	Present	Present	Absent	Putsavage 2013
	Kipp Ruin	Large pueblo	Present	Present	Present	Present	Absent	Paul 2012

¹ Large pueblos have more than a dozen rooms likely dating after AD 1200

² Includes Cliff White-on-red, Dinwiddie Polychrome, Nine Mile Polychrome, and Phoenix Polychrome

³ Trace amounts

⁴ None in surface collections

Maverick Mountain Series pottery indicative of Kayenta communities in diaspora is variably distributed in the Upper Gila/Mimbres region. At the 3-Up site in the Mule Creek Valley, we discovered relatively high frequencies of Maverick Mountain Series pottery in one locus of the site, which we interpret as a likely Kayenta enclave within the larger settlement. In addition, coursed slab masonry rubble in this area differed from the cobble-footed wall construction technique preferred by local groups. Perforated plates were also recovered from our limited excavations of the 3-Up site. In contrast, the nearby well-preserved masonry pueblo at Fornsolt lacks evidence for Kayenta immigrants. Instead, it closely resembles Tularosa phase sites to the north and west both in its ceramic assemblage and architecture (Dungan et al. 2012; Huntley et al. 2010; Dungan 2015). The terminal occupation at Fornsolt temporally overlaps (as indicated by ceramic cross-dating, especially the presence of nonlocal Pinedale Black-on-white and Heshotauthla Polychrome) with the Kayenta locus at the 3-Up site.

In the Cliff Valley, high frequencies of Maverick Mountain Series ceramics are present in the Ormand Village collection as well as a few Tsegi Orange Ware sherds made in the Kayenta region (Wilson 1998). People who built the village's adobe room blocks may have occupied a large pit structure containing Maverick Mountain Series and Gila Polychrome pottery in floor contact. Laurel T. Wallace (1998:30) suggests this structure resembles those attributed to Kayenta immigrants who settled at Point of Pines Pueblo in the Mogollon Highlands (Lindsay 1987). To our surprise, perforated plates are not reported in the ceramics chapter of the Ormand Village site report (Wilson 1998), and we found none in our reanalysis of a sample of the collection. Based on the presence of Maverick Mountain Series ceramics and perforated plate fragments at the nearby Dinwiddie site, it seems likely that at least a small group of Kayenta immigrants was also present at this site in the 1300s. An informal survey of the plowed portion of the Lichty's site, also in the Cliff Valley, revealed several perforated plate sherds, suggesting a Kayenta presence there. The Redrock Valley, to the south of Cliff, appears to have had a noticeable thirteenth-century Kayenta presence as well (see also Lekson 2002).

Evidence for Kayenta occupations along the Upper Gila River Valley, northeast of Cliff, is lacking, as it is also along the northern portion of the Mimbres River. Thirteenth-century site components in this area have little to no Maverick Mountain Series pottery and no perforated plates. This pattern suggests that the eastern terminus of the Kayenta migration was the Cliff Valley, with a few small groups perhaps pushing southeast. Small amounts of Maverick Mountain Series pottery at the Black Mountain site (Putsavage 2013) and Kipp Ruin (Paul 2012) point to a Kayenta connection, if not an actual Kayenta presence, at the southern end of the Mimbres drainage.

By the mid-fourteenth century, Roosevelt Red Ware dominated nearly all decorated ceramic assemblages in the Upper Gila/Mimbres region, replacing Maverick Mountain Series ceramics associated with Kayenta immigrants and Cibola White Ware and White Mountain Red Ware imports. Zuni Glaze Ware is also nearly absent. Roosevelt Red Ware was recovered from all areas of the 3-Up site in Mule Creek but was overwhelmingly dominant in one small, spatially discrete area that likely was one of the last room blocks built at the site. Here we found a partially reconstructible Dinwiddie Polychrome vessel on a room floor next to a partially reconstructible perforated plate. We also recovered a substantial quantity of Cliff White-on-red sherds. Comparing this assemblage with the well-documented San Pedro Valley (Lyons 2012) highlights the abundance of Cliff Polychrome and other late types in the Mule Creek Valley. In the San Pedro Valley, the ratio of Cliff Polychrome (start date of ca. 1360) to Gila Polychrome (start date of ca. 1300) is a mere 0.2, and only one example (Phoenix Polychrome) of a late type was recovered from a sample of more than 4,000 Roosevelt Red Ware sherds from twenty-five sites. The ratio of Cliff Polychrome to Gila Polychrome at 3-Up is more than 2.0, an order of magnitude higher than that of the San Pedro, indicating a larger late occupation.

During the fourteenth century, the Cliff Valley became the focal point of settlement in the Upper Gila/Mimbres region, with a maximum population during the latter half of this century. Considering the relatively large quantities of late Roosevelt Red Ware types and the widespread adoption of cremation burial that has a long history in the Hohokam region, Cliff Valley was a likely destination of Salado groups in southeastern Arizona that were emigrating from that region during the late fourteenth century. Overall, the Cliff Polychrome to Gila Polychrome ratio at Ormand Village is approximately 1.25, lower than 3-Up but still considerably higher than the San Pedro. A number of late Roosevelt Red Ware types are also present at Ormand Village, including Nine Mile Polychrome, Dinwiddie Polychrome, Phoenix Polychrome, and Cliff White-on-red.

Available evidence indicates that the northern (TJ Ruin) and eastern (Mimbres) reaches of the study area were on the periphery of initial Kayenta migration as well as the subsequent development of Salado ideology. Fourteenth-century site components in these areas are sparser than those in the Cliff Valley and Mule Creek Valley. TJ Ruin, for example, apparently has a relatively small Cliff phase adobe room block atop a much larger Mimbres stone masonry pueblo (McKenna and Bradford 1989; Huntley 2012). In addition, Roosevelt Red Ware is found in smaller numbers overall in the north and east compared with the Mule Creek and Cliff areas. For example, Roosevelt Red Ware at fourteenth-century Mimbres Valley sites tends to comprise less than 4 percent of all decorated ceramics; the Ormand Village

assemblage contains at least twice that proportion (Wilson 1998:256). The overall proportion of Roosevelt Red Ware at TJ Ruin is even lower based on systematic surface tabulations (Huntley 2012). Gila Polychrome tends to be much more common than late Roosevelt Red Ware at Mimbres Valley sites, particularly in the northern Mimbres Valley. Finally, proportions of ceramics from the Casas Grandes and Jornada Mogollon regions tend to be more common at Mimbres Valley sites than they are at Salado sites to the west (Nelson and LeBlanc 1986). The Black Mountain site (Putsavage 2011, 2013) and Kipp Ruin (Paul 2012), near the southern end of the Mimbres Valley, may be exceptions to this trend in that both appear to have large fourteenth-century components associated with both early and late Roosevelt Red Ware types.

CERAMIC PRODUCTION AND DISTRIBUTION IN THE UPPER GILA/MIMBRES REGION AND VICINITY

An important tool in resolving the various processes (e.g., migration, exchange, emulation) behind the distributions of Maverick Mountain Series and Roosevelt Red Ware pottery in the Upper Gila/Mimbres study area is provenance analysis. Here we summarize the results of our study of a large ceramic sample from southeastern Arizona and southwestern New Mexico using neutron activation analysis (NAA) and petrography in tandem (see Ownby 2012; Ownby et al. 2014). NAA measures the amounts of major, minor, and trace elements within a given sample (Neff and Glowacki 2002). Petrography involves the visual identification of both naturally occurring mineral inclusions and human-added tempers in ceramic pastes. These techniques provide us with complementary sources of provenance information that can be used to assess patterns of pottery production and distribution.

We acquired NAA data for nearly 500 Maverick Mountain Series, Roosevelt Red Ware, and utility ware sherds from ten sites with Cliff phase components in the Upper Gila/Mimbres area. We compared the Upper Gila/Mimbres data set with a smaller number of mostly decorated ware (both Maverick Mountain Series and Roosevelt Red Ware) sherds from five sites located in the Safford Basin (Buena Vista/Curtis and the adjacent sites of Spear Ranch and Krider Kiva), the Sulfur Springs Valley (Kuykendall), and the Globe area (Gila Pueblo) of the southern Tonto Basin in southeastern Arizona (see map 16.1; Ownby et al. 2014:table 1). Sherds from each sampled site contained various combinations of sand temper: volcanic, granitic, or quartz/feldspar.

Similar data from utility ware served as a control because utility ware is likely to have been made with locally available resources and distributed more locally. Ethnographic and archaeological studies have shown that utility ware, typically

used for everyday cooking and storage, tends to circulate via informal exchanges among individuals with close social or kin ties (Graves 1991; Sahlins 1972; Stark 1992). Utilitarian ware manufacture is determined both by raw material availability and technological styles, reflecting shared learning frameworks and communities of practice (Lechtman 1977; Stark et al. 1998). Decorated vessels, while constrained at least partially by these variables, may entail different production arrangements. In addition, they are often high-value items that can be exchanged over long distances between socially distant groups (Bohannon 1955; Sahlins 1972; Strathern 1971). Our study assumes, however, that potters from the same settlement likely use the same suite of clays, temper sources, and paste recipes for locally produced utility ware and locally produced decorated ware, which may not always be the case.

Statistical analysis of the NAA data revealed several large chemical compositional groups, a number of smaller groups, and a few compositional outliers and unassigned samples (see Ownby et al. 2014:table 2, figure 5). Petrographic samples selected from each site in our study area, as well as from each major chemical compositional group, helped us refine the binocular temper sorting and evaluate our NAA groups (Ownby 2012; Ownby et al. 2014:figure 7). In most cases petrographic samples assigned to the same NAA group were mineralogically similar, supporting our group assignments. The geological similarity of outcrops in southwestern New Mexico made it difficult to link some of the chemical compositional groups with specific settlements, but particular valleys do appear to have unique compositional and mineralogical signatures.

The provenance data indicate that the Mule Creek and Cliff Valleys were likely production locations for Maverick Mountain Series and Roosevelt Red Ware vessels (Ownby et al. 2014:159). Since the 3-Up site in Mule Creek, and Lichty's, Ormand Village, and Dinwiddie in the Cliff Valley have evidence of Kayenta immigrants, it is tempting to infer that, as in the San Pedro Valley (Clark and Lyons 2012), Roosevelt Red Ware production in the Upper Gila/Mimbres was initiated by these groups or their descendants. We argue that potters made Roosevelt Red Ware at several villages using similar suites of resources and that people traded this pottery within and between valleys. Compositionally distinctive subsets dominated by Roosevelt Red Ware suggest preferential selection of raw materials and/or specialized production for exchange for these decorated wares. A similar pattern of decentralized production with some degree of community specialization has been noted in other areas of the southern Southwest (Clark and Lyons 2012; Crown 1994; Neuzil 2008). It is less likely that potters residing in areas to the north and east of the Cliff Valley, such as the northern Mimbres Valley, made Roosevelt Red Ware vessels; many such vessels found there may have come from the Cliff Valley (Ownby et al. 2014:159). Northern Mimbres potters almost certainly did not make

Maverick Mountain Series vessels. This is consistent with the absence of evidence for Kayenta immigration and the low frequency of Roosevelt Red Ware at northern Mimbres sites compared with the Cliff Valley and Mule Creek.

Analysis of a smaller number of Maverick Mountain Series and Roosevelt Red Ware vessels from southeastern Arizona presents a similar picture of local production at the valley scale with limited intervalley exchange (Ownby et al. 2014:159). The Gila Pueblo sample, for example, includes a locally produced perforated plate and possibly also Roosevelt Red Ware. A small group of utility ware sherds from the Kuykendall site in the southern Sulfur Springs Valley has a distinctive compositional and petrographic signature. However, a number of Roosevelt Red Ware vessels appear to have been imported from multiple locations to this large site. In the Safford Basin, Roosevelt Red Ware from Spear Ranch is clearly locally made. The area around Spear Ranch has the densest concentration of Kayenta immigrants in the region, and a kiva similar to that found at the Davis Ranch enclave in the San Pedro Valley was excavated within 100 meters of Spear Ranch (Neuzil 2008; Woodson 1999).

Roosevelt Red Ware and the Movement of Ideas

Technological and stylistic continuity between Maverick Mountain Series and Roosevelt Red Ware pottery demonstrate the sharing of knowledge of manufacturing practices among groups of potters spread across a wide geographic area (Clark et al. 2013; Lyons et al. 2011; Lyons and Clark 2012). In addition, overall similarity in design motifs on Roosevelt Red Ware produced in different locations further attest to the sharing of ideas among potters in the Upper Gila/Mimbres region. We recorded design elements and motifs on a sample of several hundred large Roosevelt Red Ware sherds and compared this data set with a smaller sample of complete vessels from Ormand Village, Dutch Ruin, and Dinwiddie. Many of these vessels were included in Crown's (1994) stylistic study. Similar to Crown's findings, we found no clear regional patterning in design motifs or iconography among sites in the Upper Gila/Mimbres study area. However, we identified recurrent motifs that vary from region to region in the design field above the interior rim band (and serving line) on Cliff Polychrome. This is an interesting preliminary finding, since this design field is a relatively late stylistic development within the Roosevelt Red Ware tradition, first appearing around AD 1360 and unique to Cliff Polychrome and Nine Mile Polychrome. As discussed previously, this particular design field likely remained visible even when a vessel was filled. While we caution that our sample is biased toward larger sherds and many sites have very few of these, further analysis of above-rim band designs may allow us to identify the products of particular pottery making traditions or self-identifying production groups within individual drainages.

In general, our intensive research in the Upper Gila/Mimbres region agrees with the results of Crown's (1994) general stylistic analysis and supports her interpretation that use of Roosevelt Red Ware integrated diverse social groups. One major refinement is that the integrative or inclusive ideology displayed on Roosevelt Red Ware was initiated by a Kayenta community in diaspora and subsequently spread to local Hohokam and Mogollon groups in culturally diverse coalescent communities (Clark et al. 2013). With the possible exception of above-rim band designs on Cliff and Nine Mile polychromes, potters from individual villages or river valleys in the region appear to have had no clear local preference for particular suites of icons. If these vessels were indeed used for feasting, the above-rim band design may have expressed community or social group identity. Thus, despite multiple production loci, overall iconographic uniformity suggests potters from each producing settlement were in frequent contact. That many of the producing settlements are suspected Kayenta enclaves suggests the presence of a Kayenta community in diaspora that endured for nearly a century. There is also an interesting point of contrast with other well-known decorated wares, such as Middle Gila Buff Ware of the Hohokam region and Jeddito Yellow Ware of the Hopi region. Both wares exhibit stylistic uniformity on par with Roosevelt Red Ware but were centrally produced for long-distance exchange (Abbott, Watts, et al. 2007; Adams et al. 1993; Bishop et al. 1988).

MOVEMENT OF PEOPLE, OBJECTS, AND IDEAS IN THE UPPER GILA/MIMBRES REGION

In the Upper Gila/Mimbres region, demographic and ceramic data reveal a complex pattern of overlapping movements happening simultaneously and at multiple spatial and temporal scales. Our research indicates that Kayenta immigrants who resettled in the Upper Gila/Mimbres area during the late thirteenth century did not move into a sparsely populated frontier as initially hypothesized but instead entered a landscape occupied by local groups and other immigrants. Within our study area, Kayenta immigrants occupied the Mule Creek Valley, the Cliff Valley, and possibly the Redrock Valley and the southern Mimbres Valley. Few if any Kayenta groups moved into the northern Mimbres Valley and TJ Ruin. The fertile Cliff Valley seems to have been the primary destination area for these newcomers. Most Upper Gila (and perhaps southern Mimbres Valley) settlements with Kayenta enclaves developed into large Salado villages during the fourteenth century. Western Salado groups apparently joined some of these settlements in the second half of this century as settlements were depopulated in southeastern Arizona. Most large Salado villages produced Roosevelt Red Ware vessels.

The relative proportions of local and immigrant populations cannot be ascertained with the available data, nor are the organizational units of migrant groups archaeologically visible. In the Lower San Pedro, local groups were the majority and Kayenta groups settled in clusters of hamlets, initially remaining spatially segregated from local groups (Clark and Laumbach 2011:311). Except for one locus at the 3-Up site, we have little evidence of a similar phenomenon in the Upper Gila/Mimbres region. We also suggest differences in initial reactions to and long-term effects of migrants in the Upper Gila/Mimbres region compared with the Lower San Pedro and elsewhere in southeastern Arizona. In the Lower San Pedro, local groups initially responded to immigrants with overt displays of identity (in pottery and architecture), by aggregating into larger villages, reviving their local decorated ceramic tradition, building platform mounds to mark territory, and intensifying local subsistence practices. Ultimately, social boundaries broke down and Kayenta groups were at least partially assimilated, with Roosevelt Red Ware replacing both immigrant Maverick Mountain Series and local decorated ceramic traditions and local groups participating in immigrant-controlled obsidian exchange networks. We find no evidence for similar strong local responses to immigration in the Upper Gila/Mimbres region. A key difference may be the absence of established irrigation communities and the greater availability of arable land in the Upper Gila/Mimbres region, which mitigated competition among local and immigrant groups.

As in the Lower San Pedro, the fact that all known Roosevelt Red Ware production areas in the Upper Gila/Mimbres region have evidence of earlier Kayenta enclaves is strong circumstantial evidence that immigrants played a pivotal role in the production of this important ware. Further support for this inference derives from the knowledge that Kayenta pottery traditions are the technological and iconographic antecedents of fourteenth-century Roosevelt Red Ware (Crown 1994; Lyons 2003; Lyons and Lindsay 2006) further supports this inference. Although more work is required to firmly establish and characterize the Kayenta-Salado connection, the available evidence suggests that a network that connected potters of Kayenta descent facilitated communication between potters producing Roosevelt Red Ware in multiple locations for at least a century after migration. This network had many properties of a community in diaspora, including population dispersal, loss of homeland, selective maintenance of cultural traditions, and transformation in exile (Clifford 1994; Lyons et al. 2011). The presence of this community is further supported by temporal and spatial trends in the distribution of Mule Creek obsidian, which was widely circulated throughout southeastern Arizona and southwestern New Mexico. While we currently lack evidence for Kayenta architectural hallmarks (e.g., entry boxes) in the Upper Gila/Mimbres region, this may be due to a lack of intensive excavation of fourteenth-century settlements by professional

archaeologists. Moreover, many sites do have locally produced Maverick Mountain Series pottery and perforated plates, both clear indications of connections among people with shared technological traditions.

Decentralized production and widespread use of Roosevelt Red Ware by both migrants and locals argues for the formation of multiple place-based coalescent communities in the fourteenth century. Culturally diverse groups were integrated, at least in part, by a new ideology expressed through the iconography on these Roosevelt Red Ware vessels. Moreover, the highly uniform repertoire of design elements and motifs used on these vessels throughout much of the fourteenth century (in the Upper Gila/Mimbres and elsewhere) suggests that potters—likely Kayenta descendants linked by shared heritage—were in close communication for an extended interval. Coalescent communities were characterized by localized exchange of ideologically powerful pottery and down-the-line trade of obsidian from key sources like Mule Creek.

That fourteenth-century community organization in the Upper Gila/Mimbres region has both coalescent and diasporic properties should not be surprising considering the population movements and demographic upheaval that occurred immediately before and during this interval. Although coalescence and diaspora are potentially competing organizational forms (shared place separated by culture versus shared culture separated by place), they can also be complementary, depending on context. Immigrant minorities with strong identities are pulled in two directions: maintaining homeland traditions and assimilating into the cultures of host majority populations. In contexts where immigrant and host groups frequently interact, coalescent organizations and institutions deemphasize cultural differences and facilitate integration (Kowalewski 2007). Such settings are conducive to inter-mating, cultural hybridization, religious syncretism, and the development of inclusive ideologies. However, solidarity based on a real or imagined shared cultural heritage and loss of homeland may be advantageous in situations where immigrants are interacting with other immigrants. In these contexts culture can transcend space, creating trans-regional networks through which goods and ideas circulate, affording immigrants opportunities not available to local groups.

The Kayenta community in diaspora and Salado coalescent communities coexisted successfully in portions of the southern Southwest for several generations at least. However, near the end of the fourteenth century, there appears to have been a breakdown of the Kayenta community in diaspora and the reassertion of local traditions, as observed in the appearance of late regional Roosevelt Red Ware types. Local traditions include pre-Kayenta attributes such as smudging and white-on-red design configurations in the Upper Gila/Mimbres area and Safford Basin, as well as the incorporation of red paint into black and white design fields in the

Phoenix Basin and vicinity (Lyons et al. 2011). This breakdown in Roosevelt Red Ware homogeneity is perhaps most apparent in the differences between eastern and western Salado that roughly correspond to earlier Mogollon and Hohokam culture area boundaries as they have been traditionally defined.

This chapter has discussed both migration and the widespread movement of ideas without substantial population movement, offering an explanation for the latter. Using distinctive artifacts that tend to move with the people who produced them (i.e., utilitarian ceramics, perforated plates, architectural features, and Maverick Mountain Series pottery), we identified definitive Kayenta immigrant enclaves and potential enclaves that warrant further investigation. As a minority dispersed across southwestern New Mexico and southeastern Arizona, the Kayenta maintained many aspects of their identity and remained in relatively close contact with each other as a community in diaspora.

A strong case can be made that the production of Roosevelt Red Ware, by far the dominant decorated pottery tradition across the southern Southwest after AD 1300, was initiated by the Kayenta and maintained by their descendants. This explains the widely decentralized production of Roosevelt Red Ware as well as the high degree of stylistic and technological homogeneity until the late fourteenth century (Lyons and Clark 2012). Roosevelt Red Ware both reflects Kayenta homeland traditions and represents something new that had strong and widespread appeal. These vessels were exchanged to various local groups across much of the southern Southwest, attesting to this appeal. The increasingly visible iconography on Roosevelt Red Ware symbolized a much-needed inclusive ideology that attempted, with variable success, to integrate groups from a variety of cultural backgrounds into coalescent communities. The power of Salado ideology goes a long way in explaining the exchange of Roosevelt Red Ware pottery far beyond the distribution of Kayenta enclaves and across multiple cultural boundaries. How a relatively small immigrant minority, even as a community diaspora, managed to exert such influence over various local majorities remains an intriguing research question.

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NOTES

1. All dates AD unless otherwise noted.
2. Harold S. Colton (1953:52) defines a series as a sequence of types, found in a particular geographic area, within a broader ware category. In other words, a series can be considered a subset of a ware. The Maverick Mountain Series was originally classified as a subdivision of White Mountain Red Ware (Colton 1955, 1965a), but Roy L. Carlson (1982) later argued that the series was more technologically and stylistically similar to Tsegi Orange Ware. We follow the lead of recent researchers (e.g., Lyons 2003; Neuzil and Lyons 2006) in considering the Maverick Mountain Series to be distinctive from both of these ware categories.
3. Our investigations in Mule Creek have shown that this was not true everywhere in the Upper Gila/Mimbres region. It seems more likely that local populations became less archaeologically visible, perhaps at least in part because of a dramatic decrease in decorated ceramic frequencies at early thirteenth-century sites.

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